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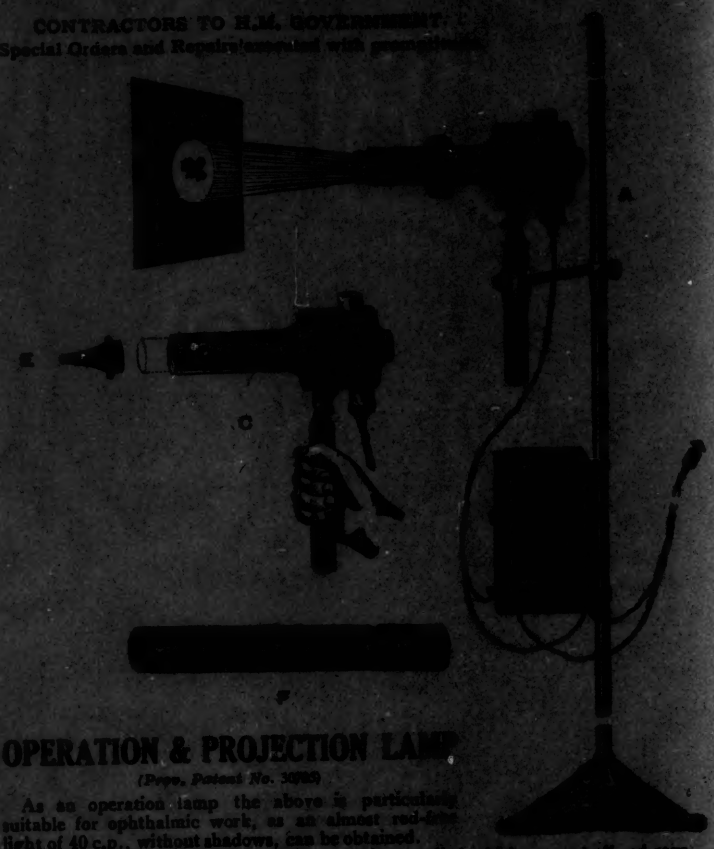

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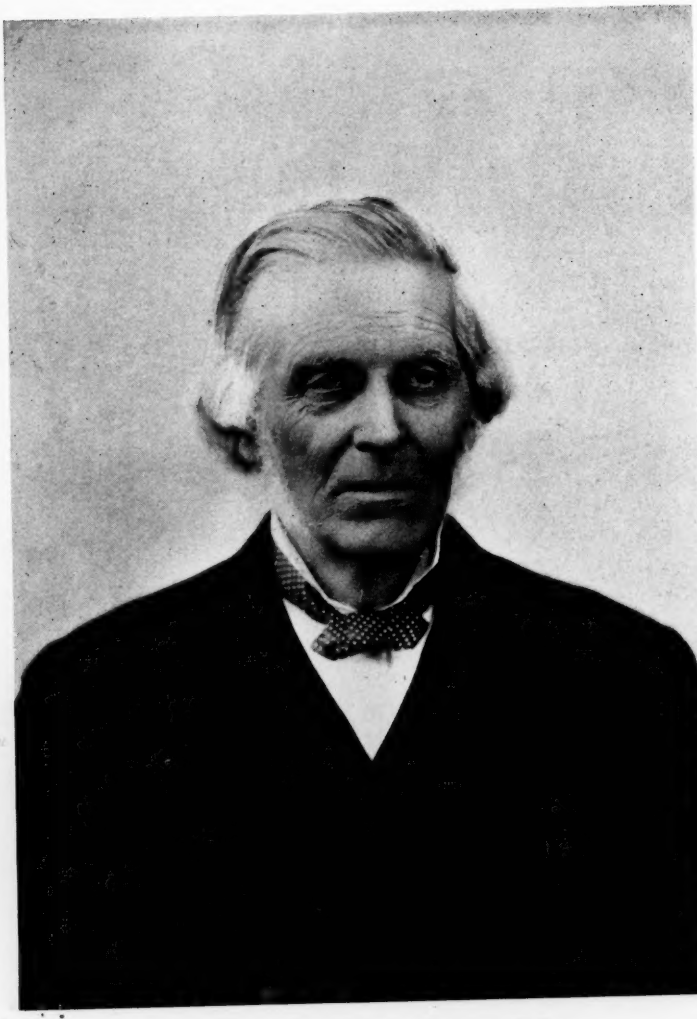

SIR WILLIAM BOWMAN, BART., F.R.S.,

(1816—1892)

THE BRITISH JOURNAL

OF

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16.—SIR WILLIAM BOWMAN, BART., F.R.S., 1816-1892

BY

R. R. JAMES

LONDON

THE great man whose life I endeavour here to portray has been dead for more than thirty-three years; there can be few now living who knew him in his prime, and to most of us he is only a name: a name, it is true, highly honoured and in daily use in ophthalmology all the world over.

Great as a physiologist, an anatomist and as a general surgeon, it is as an ophthalmologist that Bowman will go down in history among the immortals, for to him, in this country at any rate, were largely due the placing of ophthalmic surgery upon a sure scientific basis, and its rise to a pre-eminent and dignified position as a speciality.

He was born at Nantwich on July 20, 1816, almost exactly a year after the battle of Waterloo. He grew up in the lean years following the titanic struggle of the Napoleonic wars; saw the great industrial development of the early middle years of the last century, and died in 1892, at a good old age, full of years, honours, and the knowledge of a well-spent life.

His father was John Eddowes Bowman, a banker, of Nantwich, and later of Welshpool and Wrexham. William was the third of his four sons. His three brothers who all died before him had successful careers; one being a classical scholar of some distinction; one, an architect; and the last a professor of chemistry. His mother was Elizabeth, daughter of William Eddowes of Shrewsbury, a well-known bookseller of that town.

Nantwich, the place of his birth, is a historic town in the County Palatine of Chester, famous for its salt springs. The name is derived from the British word "nant," a brook or marsh, and the Saxon "vic," by corruption "wich," a vill or settlement. The "wich" seems to have a special affinity for places where salt is worked, Droitwich, in Worcestershire, being another example. Among the natives of Nantwich, it is interesting to remember the name of John Gerarde, the herbalist, born there in 1545. At the present time Nantwich is chiefly famous for its fine old timber houses, like so many other market towns on the Welsh border, and for its stately church, the architecture of which belongs mainly to the Decorated period.

It is to be assumed that Bowman's father was either the proprietor of a local private bank, or more probably the manager of the local branch of the county bank. These were the days before the era of the large joint-stock companies; the county banks were profitable to their proprietors, and in spite of the prejudices of the landed gentry of the period against any form of trade an exception was often made in respect of the banking business; indeed, it was sometimes found that a post in the county bank was not despised by a local squire with a large family of sons. Instances in point occur in the neighbouring county of Shropshire, where, in Shrewsbury the banking business was largely in the hands of Messrs. Eyton and Burton, both very good names in that proud county. As a matter of fact, Sir William Bowman's grandfather was in business in Nantwich, and so it is probable that the son was manager of the local branch of the bank and not the proprietor.

J. E. Bowman was a Fellow of the Linnaean Society, and a geologist of more than local repute. He is credited with having given some assistance to Sir Roderick Murchison in his great work on the Silurian system. His wife was of an artistic temperament, and the children grew up in artistic surroundings. Bowman's early studies seem to have been directed by his father chiefly in botany and geology; but at the age of ten years he was sent with two of his brothers to a school well known at that time, Hazelwood, near Birmingham, to be under the care of Mr. Hill, the father of Sir Rowland Hill of postal reform fame, an earnest and somewhat eccentric pedagogue; eccentric in this, that he dis-

approved of corporal punishment at a time when its practice was much rifer among the seminaries of England than it is in our days. Bowman spent six years at this school. It is on record that he took a prominent part in the management of the school magazine, not as an editor, but actually as printer, for the master seems to have owned a private press, many of the proof sheets being signed by Bowman. A model of the school buildings cut out of cardboard at this time by Bowman and another schoolboy is proof that besides learning to use his eyes, he had also acquired some manipulative dexterity with his fingers.

On leaving school he chose the medical profession and at his own request was apprenticed to Joseph Hodgson, who at that time was one of the surgeons to the Birmingham General Hospital. Hodgson had an extensive reputation as a surgeon in the Midland counties, and later, after moving to London, became F.R.S. and President of the Royal College of Surgeons of England. He was a member of the Society of Friends.

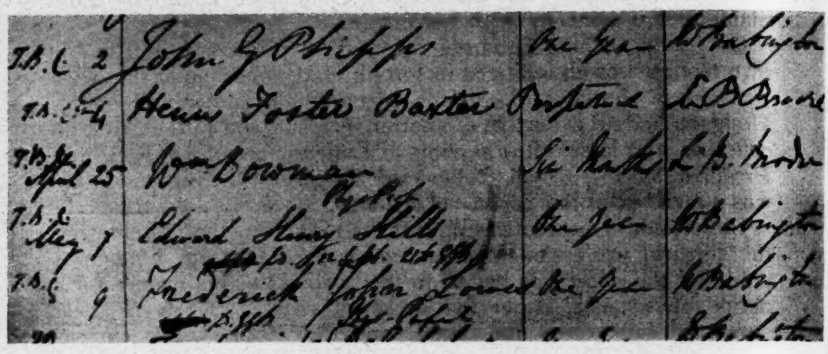
In those days apprenticeship was the regular method of entering the surgical profession. Indentures were drawn up, a fee was paid and the pupil was bound to the business of his master for a period of, usually, either five or seven years. Many of these surgeons' indentures are extant, and they form rather curious reading. If the master was lacking in conscience he usually pocketed the premium, gave his pupil the run of the surgery, fed and boarded him and allowed him to work out his own salvation by picking up what he could of medical education in that most practical of all ways, by teaching himself. But there was no such laxity between Hodgson who was a Quaker and doubtless took his duties seriously, and Bowman, who was an enthusiast for work and lived in the Hospital as a House Pupil. During his holidays Bowman saw a good deal of country practice at home through his friendship with Mr. Griffith of Wrexham.

From the first he interested himself in pathology as well as in practical surgery, following all post-mortem examinations, drawing and recording what he saw. His first microscope was given to him at this time by Dr. Blakiston, physician to the hospital, for whom he had made a large number of measurements of the cardiac orifices. To this period also belongs his first paper on a medical subject: "A Note on Influenza as it occurred in Birmingham in 1835." This was not published at the time, but it is included in the collected edition of his works. In the following year appeared Ryland's work on "Diseases of the Larynx and Trachea." Some of the cases and five of the coloured illustrations were by Bowman, done in his eighteenth year.

In 1837, he came to London and joined the Medical Department of King's College. It is stated that he took the M.R.C.S.

in 1840, but in the preface to one of his works he notes that he was appointed Assistant Surgeon to King's College Hospital on its foundation in 1839. In 1844, he was elected F.R.C.S., Eng. The true date of his M.R.C.S. is June 10, 1839.

I find the name "Wm. Bowman" entered on the Pupils' Register of St. George's Hospital on April 25, 1838, as a six months' pupil of Sir Benjamin Brodie. A copy of this signature is here appended.



Although I know of no other evidence that he was ever connected with my own school, the dates fit in so well that I think it highly probable that Bowman took a short course under Brodie, who was at that time at the zenith of his fame. In an address delivered before the meeting of the British Medical Association at Chester, in 1866, Bowman adverts to Brodie's death, and "recalls with gratitude the converse—in later years, the intimate and friendly intercourse—I enjoyed with this considerable man." His presentation copy of "The Lectures on the parts concerned in the Operations on the Eye" to Brodie, has the following inscription on the fly-leaf: "Sir B. C. Brodie, Bart., with the author's compts. and thanks." This copy is now in the possession of my senior colleague, Mr. Grimsdale, who has kindly allowed me to give the transcript. Many years after the date of publication of this book, Brodie's cataracts were removed by Bowman, a mark of confidence from an acknowledged head of the profession to one who was much junior, and who may very possibly have been at one time his pupil, as gratifying to the junior as it is unusual.

Physiological Enquiries

Bowman's great physiological investigations were for the most part undertaken during the years 1839-1842. In these three years he did the microscopical work for which he will be for all time

famous, on the structure of striated muscle, and on the structure of the kidney. These two papers were read before the Royal Society, the first on June 18, 1840: that on the kidney on February 17, 1842. His original work secured him his election as F.R.S. in 1841, at a very early age. In 1842, he was awarded the Royal Medal of the Royal Society. His papers were illustrated entirely by his own drawings. They will be found in Volume I of his collected works. Besides these original papers, a very important piece of work was that on the structure of the mucous membrane of the alimentary canal. This appeared in the "Cyclopaedia of Anatomy and Physiology." In 1843, appeared the first part of the "Physiological Anatomy and Physiology of Man" by R. B. Todd and William Bowman. Its concluding part appeared in 1856. This was an epoch-making work, for it was the first of its kind to give an accurate description of the histology of the organs of the body. Most of the illustrations were by Bowman, Todd being no artist. It is recorded that the junior author was so sure of hand that many of the drawings were made on the wood blocks directly.

The following excerpt from the paper on the "Malpighian bodies of the Kidney," his second paper read before the Royal Society, gives a good example of his style; his meticulous accuracy and his modesty.

"The tubes on issuing from the Malpighian bodies invariably become greatly contorted. I have on one occasion seen two of them unite, and from their dichotomous mode of division, when traced up from the pelvis, there can be little doubt that this is constantly their disposition. I have never, in all my examinations, met with any appearance of an inosculation between different tubules. The tortuous tubes unite again and again in twos, and finally, under the name of pyramids of Ferrein, become straight and converge towards the pelvis, forming the medullary cones or pyramids of Malpighi. The Malpighian bodies are imbedded in a kind of nidus formed among these convolutions, and are touched on all sides by the surrounding tubes. As the emergence of the tube from the Malpighian body can be seen only at one point, it is not wonderful that it should have been overlooked, and that the demonstration should have seemed clear, that the Malpighian bodies merely lie among the tubes, and have no connection with them."

The Physiological Anatomy and Physiology of Man

This great work, which became known to generations of students, for short, as "Todd and Bowman," was projected in

1839. It came out in parts as already stated. Of the 298 illustrations, 120 were by Bowman himself. The work was intended "to furnish the student and practitioner in medicine and surgery with a plain and accurate view of the intimate structure and functions of the human body, and is accommodated in its plan and arrangement to the physiological lectures delivered in King's College, London." It was dedicated to Sir Benjamin Brodie, and for many years held the field alone as *the* exposition of physiology in the English language.

In 1839, Robert Bentley Todd began the publication of "The Cyclopaedia of Anatomy and Physiology," in the words of Mr. Henry Power, "the largest and most important work of the kind that has appeared in England, and still valuable for the number and variety of the original articles contributed by men of the highest standing." Bowman's first contribution to it is found in the third volume. The articles on mucous membranes, muscle, and the Pacinian Bodies were all his work.

King's College and Hospitals

Bowman began work at King's College under John Simon, afterwards Sir John Simon, P.R.C.S. Simon was Prosector to Todd for the physiological lectures. In 1838, Simon was appointed Second Demonstrator of Anatomy; his senior colleague being F. T. MacDougall, who later left medicine for the Church and became Bishop of Labuan. Simon's new appointment gave Bowman a step up, and he passed on to the Prosectorship in Physiology. In this year it is stated that he visited several of the foreign hospitals in Paris, Vienna, Germany, and Holland; and I opine that he also worked under Brodie at St. George's Hospital. In 1839, MacDougall left King's College for Oxford, on his way to a cure of souls and the episcopacy of Labuan, and Simon became Senior Demonstrator; Bowman becoming his junior colleague and being placed in charge of the museum as curator. He was appointed Assistant Surgeon to King's College Hospital in 1840; Surgeon in 1856; and retired from his surgeonship in 1862.

The surgical staff of King's College Hospital was overshadowed by the personality and forcible character of Sir William Fergusson, the great operating surgeon of the day. Simon was Fergusson's deputy, while Bowman was Assistant to Professor Richard Partridge, the father of Sir Bernard Partridge, the artist. At a later date, Simon having left King's College for St. Thomas's Hospital, Bowman became Senior Assistant Surgeon, and the junior post was filled, I think, by Mr. Henry Lee, of my own

hospital. Lee returned in 1861, or thereabouts, to St. George's, and it is on record that he had been heard to say jokingly that while he was at "King's" it was considered an honour for him to hold Fergusson's knife. This is probably not quite true, as Lee was a distinguished authority on syphilis and no mean surgeon, but the joke gives a graphic picture of the supremacy of Sir William Fergusson.

Pressure of private work compelled Bowman a few years later to resign his appointment on the surgical staff of King's College Hospital. He kept up his connection with the College, however, for up to the time of his death he was an active member of the Council, and Chairman of the Medical Committee. Bowman married in 1842, Miss Harriet Paget, the daughter of a Leicester surgeon. She survived him. On arriving in town he took lodgings near the Strand, and later moved to Dr. Robert Lee's house in Golden Square. In 1850, he moved to 5, Clifford Street, the house of the illustrious Liston, the inventor of the splint which bears his name, not the actor. From 1851-1871, Bowman had a house at North End, Hampstead.

Ophthalmology

Bowman was appointed Assistant Surgeon to the Royal London Ophthalmic Hospital in 1846. He became surgeon to the Institution in 1851, and retired under the age limit in 1876. His first important paper in ophthalmology was read at Oxford in 1847, at the meeting of the British Association. This was "On some points on the Anatomy of the Eye, chiefly in reference to the Power of Adjustment." In this paper he demonstrated simultaneously with, but quite independently of, Bruecke, the structure and function of the ciliary muscle.

In 1851, appeared Helmholtz's ophthalmoscope, and in this year was held the Great Exhibition, and there met at Moorfields Eye Hospital three remarkable men, von Graefe, Donders, and Bowman. A warm friendship sprang up between the three, to be broken only by death; that of von Graefe occurring in 1870, while Donders lived till 1889.

In 1849, appeared "The Lectures on the Parts concerned in the Operations on the Eye and on the Structure of the Retina," delivered at the Royal London Ophthalmic Hospital, Moorfields, June, 1847, to which are added a paper on "The Vitreous Humour," and also a few cases of ophthalmic disease, published by Longman, Brown, Green and Longman. The dedication runs as follows:

To

JOSEPH HODGSON, Esq., F.R.S.,

late Surgeon to the General Hospital at Birmingham,
in grateful recollection of early kindness and
encouragement during five years spent
within the walls of that noble Institution:

and to

JOHN RICHARD FARRE, M.D.
FREDERICK J. FARRE, M.D.
GILBERT MACKMURDO, Esq., F.R.S.
JOHN DALRYMPLE, Esq.
JAMES DIXON, Esq.
GEORGE CRITCHETT, Esq.
ALFRED POLAND, Esq.

My colleagues at the Ophthalmic Hospital, in
token of sincere respect and esteem:
This small work is
Dedicated.

My own copy of this work contains Bowman's signature in pencil on the fly-leaf. The tone of the preface is almost apologetic: "The following lectures were hastily put together, and were delivered nearly in their present shape, in the summer of 1847, with the simple object of exciting in the minds of the pupils some interest in the study and treatment of eye diseases. They are quite elementary . . . . It is a matter of regret to the author, that want of leisure has rendered it impossible for him, in this reprint of them from the *London Medical Gazette*, to hazard any attempt at making them less imperfect than they are." A footnote in ink states that "the lectures were delivered on June 8, 15, 22, and July 6. Part III of 'The Physiological Anatomy and Physiology of Man,' containing Chapter XVII, on vision, etc., was published in April, 1847." The paper on "The Vitreous Humour" was published in the *Dublin Quarterly Journal of Medical Science* in 1848; and the cases of ophthalmic disease were selected chiefly on account of their having some reference to the subjects of the lectures. "A tabular statement has also been appended of the cases treated, and the principal operations performed at the Ophthalmic Hospital during the last ten years. This has been compiled by Mr. Ledger, the intelligent House Surgeon to the Hospital, from the Annual Reports drawn up by the medical officers, and regularly published by the authorities

Barraud & Jerrard.
Photos.

96, Gloucester Place,
Portman Sq^re W

Yours truly

C. Darwin

of the Institution." This preface is dated March, 1849, from 14, Golden Square. These lectures deal almost entirely with the normal histological appearances of the different parts of the eye-ball, and show Bowman at his best on a subject peculiarly his own.

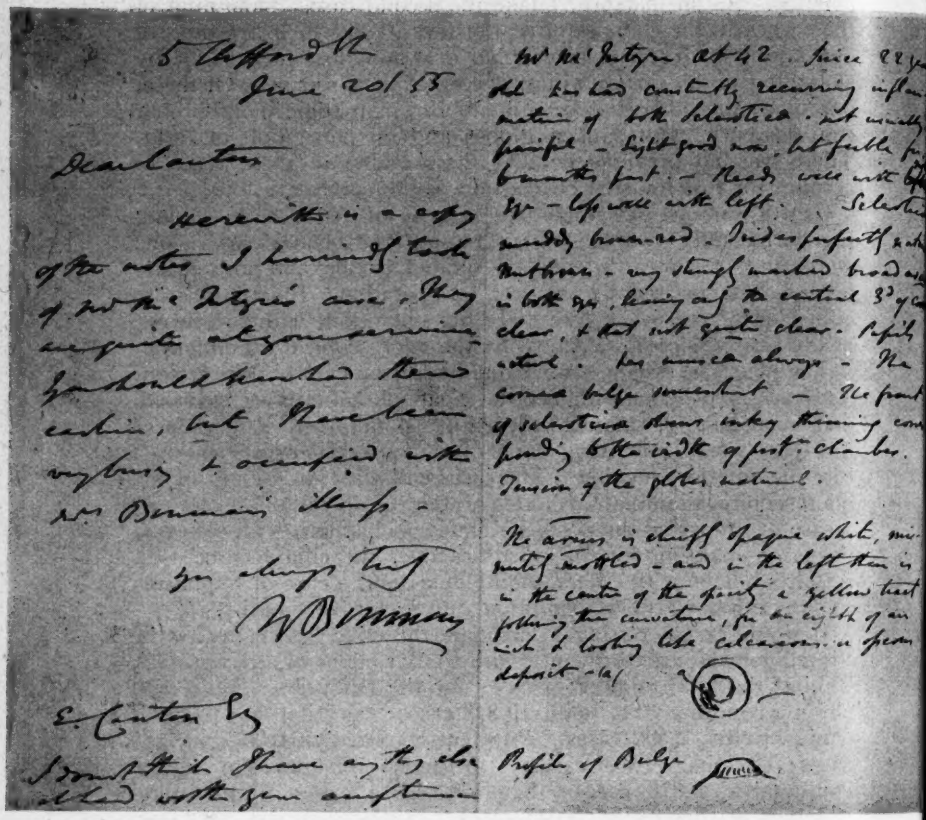
The appendix contains notes of 22 cases of ophthalmic disease. The first ten deal with corneal conditions; active ulceration, or nebulae. As an instance, I take the second case, "sloughing of the cornea in the collapse of scarlet fever," in which five boys of one family had scarlet fever; two of whom lost their sight by sloughing of the cornea within a week of their seizure. Of these, one died; the other was brought to Bowman some months after convalescence, with sunken globes and no perception of light. There was no previous debility discoverable in these cases to account for this unusual destruction of the corneae.

Case 9 was one of symmetrical opacity of the corneae, extending horizontally over the central region, and obstructing vision; consisting of an earthy deposit limited to the anterior elastic lamina, and successfully removed by operation. Illustrations are appended of the eye before and after operation, with a drawing of the earthy deposit as shown by the microscopical examination.

The next case was a similar one under the care of Mr. Dixon. Two cases of pyaemia with metastatic panophthalmitis are recorded, and some cases of cataract relieved by spontaneous depression of the lens, vision remaining; and of cataractous lenses dislocated into the anterior chamber. The cases end with an account of the microscopical examination of an eye after the operation of solution; a case of dropsy of the posterior aqueous chamber, with synechia posterior—bulging of the sclerotica over the ciliary processes, *i.e.*, iris bombé with ciliary staphyloma; and a case of hyphaema undergoing very slow absorption during twelve months.

It would be interesting to compare the table drawn up by the "intelligent House Surgeon," with similar tables of a recent date. Taking the total number of cases for the ten years: Acute and chronic conjunctivitis, total, 19,848 cases; catarrhal and pustular conjunctivitis, 7,592 cases. Purulent conjunctivitis (adults), 187 cases; (infants), 1,590 cases. Strumous inflammation of the conjunctiva, 5,976 cases. Scleritis, 1,056 cases. Ulcers and opacities of the cornea, 5,085 cases. Conical cornea, 60 cases. Iritis, 1,143 cases. Cataract, 1,531 cases. Amaurosis in various degrees, 4,865 cases (this was before the ophthalmoscope was in use). Inflammation of internal tunics and glaucoma, 1,747 cases. Neuralgia, palsy third, sixth, and seventh nerves and strabismus, 835 cases. Lid inflammation, 1,029 cases. Lid tumours, 898 cases. Tinea, lippitudo and trichiasis, 577 cases. Inversion and eversion of lids, 44 cases. Lacrymal disease, 1,100 cases. Wounds of the eye, etc., 2,302 cases. Fungus of the globe or appendages, 24

cases. Tumours of the orbit, 16 cases. Miscellaneous, 32 cases. Escaped registration, 2,500 cases. Making a grand total for the ten years of 65,353 cases. The operation table may be abstracted as follows: Cataract extraction, 451 cases; depression, 26 cases; solution, 396 cases; congenital, 110 cases; dislocated lens, 6 cases;



artificial pupil, 123 cases; tumours, 13 cases; pterygium, 1 case; staphyloma, 18 cases; strabismus, 188 cases; miscellaneous, 2 cases; entropion, 49 cases; cilia dissected out, 7 cases; globe extirpated, 4 cases; fistula lacrymalis, 20 cases. Making a grand total for the ten years of 1,419 operations.

Of Bowman's other work in the field of ophthalmology must be mentioned his advocacy of his friend von Graefe's operation

of iridectomy for glaucoma; his sounds for the treatment of lacrymal obstruction and his work on conical cornea, detached retina, and the use of two needles in needling operations. All have used Bowman's stop needle, and some of us have probably used his lacrymal probes; but the writer can claim to have used a Bowman's corneal trephine. When I did my first trephine operation for glaucoma in the year 1910, I used the only trephine I could find at St. George's Hospital, probably one of the few remaining in England at that date, a Bowman's small trephine with the graduated scale on the plunger to mark the depth of the cut. It cannot have been used for many years, but it worked perfectly, and I tapped the anterior chamber without any difficulty.

The Ophthalmic Hospital Reports began their career in 1857 under the editorship of J. Fremlyn Streatfeild. Bowman was doubtless one of the prime movers in the organization of this venture. He wrote some papers which were published in the earlier volumes.

The Ophthalmological Society of the United Kingdom

The foundation of the Ophthalmological Society was first mooted in 1880, and a committee met at Bowman's house to make arrangements and to draw up rules. Sir Thomas Barlow and Mr. Waren Tay are the sole survivors of this Committee. Everyone knows that Bowman was the first President, and that he held office for three years, and that the Bowman Lecture was founded in his honour in 1883 to mark his pre-eminent position in ophthalmology. Bowman saw the new venture launched, and delivered the usual Presidential addresses during his years of office. It may not be so generally known that he was the moving spirit in the foundation of the Society's Library, now called the Bowman Library. He presented a couple of good oak bookcases, and gave annually till his death, a sum of £50 towards the upkeep of the library. This gift was continued by the family of Sir William Bowman into the early years of the present century.

Conclusion

Power, in his memoir in the collected edition of Bowman's works, says that "the natural bent of his mind was towards pathology and operative surgery; that he disliked being called an oculist, and always declined the appellation, saying that he was a surgeon. After the death of Dalrymple, the heads of the profession, represented by Sir James Clark, Todd and Liston, strongly supporting him, the tide of ophthalmic practice became too strong to be resisted, and he gave himself up to it. His careful and prolonged work with the microscope was an excellent introduction

to the delicate manipulations required for the successful prosecution of ophthalmic surgery, and it was soon generally recognized that he possessed extraordinary skill, both in the diagnosis and in the operative treatment of the diseases of the eye."

"The want of good nursing in King's College Hospital led to the establishment by Todd, Bowman, and others, of St. John's House and Sisterhood. In this connection he was able when the time came to aid Miss Nightingale by sending out trained nurses to the East at the time of the Crimean War, and he was a member of the Council of the Nightingale Fund until his death."

"In consultation he was gentle, patient and thoughtful; alive to, and quickly seizing, the salient points of every case; very reserved, giving his opinion in a few words, but decisively, both as to forecast and treatment." A glaucoma patient of much experience said of him "that his touch was the lightest and yet the most inquiring of all those under whose care he had placed himself." "Another who knew him well said that one of his most striking characteristics was the power he possessed of concentrating his thoughts for the time on the one subject he was investigating. When iridectomy and tension of the eye engaged his attention, he thought of nothing else; and so with conical cornea and detachment of the retina."

"Though delicate and fragile both in form and feature, he was able to endure much work, and rarely suffered from any disturbance of health, with the exception of occasional headaches, and in later years slight attacks of sciatica. He was abstemious in his habits, eating little and drinking less. He was an early riser, and a non-smoker."

Personal Recollections

In response to a request relating to this memoir, Mr. Priestley Smith, one of the very few now living who can speak from personal recollection, writes as follows: "Early in 1874, having been house surgeon at the Birmingham Eye Hospital for two years, and being armed with letters of introduction, I called on Mr. Bowman in Clifford Street. After a few quiet words he asked me whether I should like to be one of his clinical assistants at Moorfields, and, as I was afterwards told, in disregard of a rule of the Hospital, he nominated me to that coveted post. In my case it meant little more than the privilege of closely watching his work. I have heard that even in the earliest days of his anatomical teaching at King's College, his manner had a peculiar fascination for those around him. It certainly was so at Moorfields. His dignity, his calmness of speech and of movement suggestive of power in reserve, and the refined expression of his face were

irresistible. Watts's fine portrait of him in earlier life reproduces this charm.

"He spoke little and always carefully and to the point, but not always without humour. One day in the theatre after the excision of an eye, the question of suturing the conjunctiva was raised. He said: 'I think not; it presents two difficulties; one in putting it in, the other in getting it out.' We had no cocain then. When I called on him to say good-bye and spoke doubtfully of succeeding as a specialist, he said: 'You will be sure to succeed—if you cure your patients.'

"For years he held the leading place at all the chief gatherings of ophthalmic surgeons. In 1880, the British Medical Association held its annual meeting at Cambridge; Bowman presided over our section and his intimate friend Donders was an honoured visitor. The University conferred the degree of LL.D. on both, and the enthusiasm with which the waiting section received them on their arrival from the Senate House in their new robes was something to remember. In 1881, Bowman presided over our section of the Seventh International Medical Congress, in London. His inaugural address showed finely his ideals, his simplicity, and his modesty.

"It was through his Presidency for three years of the Ophthalmological Society, founded in 1880, that most of the younger men of that time had the opportunity of knowing him. It was through his influence that the Society rose so rapidly into strength and importance. He was an ideal President commanding universal respect without self-assertion. I have always regarded it as a privilege and advantage to have entered on my career in those days."

In 1884, a baronetcy in recognition of his scientific attainments was conferred on Bowman. He remained in practice until he was 70 years of age, and he continued to see a few patients almost to the end of his life.

His portrait by Ouless was exhibited at the Royal Academy in 1889. At the same time, or rather in July, 1888, the year of his final retirement, the Bowman Testimonial Fund was inaugurated at a meeting held at Sir George Johnson's house. It was decided that the portrait already referred to should be painted, and that his publications should be reprinted. Professor Burdon-Sanderson and Mr. J. W. Hulke were chosen to edit the published works, which appeared in two volumes in 1892. The secretaries to the Fund were Messrs. W. A. Brailey and W. H. H. Jessop.

Sir William Bowman moved from Clifford Street to his country house, Joldwynds, not far from Dorking. He caught a chill while

superintending the removal of his library from London to Surrey, and died of pneumonia on March 29, 1892. His burial took place on April 1, in the churchyard of Holmbury St. Mary, and a memorial service was held at St. James's, Piccadilly, on the same day.

In ending this all inadequate memoir of one of the founders of our speciality I should like to quote the epitaph written by the widow of another great physiological surgeon of an earlier day, probably the greatest of all time, namely, John Hunter; the sentiments of which seem to me to be peculiarly adapted to the case of Bowman, whose own untiring search for truth was so marked a feature of his character.

" Here lies in awful silence, cold and still,
One whom no common spark of genius fired;
Whose reach of thought Nature alone could fill,
Whose deep research the love of truth inspired.

Hunter! if years of toil and watchful care,
If the vast labours of a powerful mind
To soothe the ills humanity must share,
Deserve the grateful plaudits of mankind.

Then be each human weakness buried here
Envy would raise to dim a name so bright:
Those specks which in the orb of day appear
Take nothing from his warm and welcome light."

In conclusion I must state that the chief authorities which I have consulted are the two volumes of the collected works: Bettany's "Eminent Doctors, their Life and Work," the obituary notice contributed to the *Ophthalmic Review* by Mr. Priestley Smith, 1892, p. 129; and the article contributed to the *Annals of Medical History*, 1924, by Dr. Burton Chance of Philadelphia. The reproduction of the signature in the Pupils' Register of St. George's Hospital is given by permission of the Dean of the Medical School, Dr. James Torrens. One of the pictures of Bowman is reproduced from a photograph published in 1873, in a series of volumes dealing with eminent medical men at home and abroad, by the courtesy of Messrs. J. and A. Churchill, the publishers. The frontispiece is from a photo of Bowman taken about a year before his death, kindly lent by Mr. Lawford; it was reproduced in the obituary notice in the *Ophthalmic Review* in 1892. The last illustration is from a letter with notes on a case by Bowman which is in my possession.

THE DEVELOPMENT OF THE HUMAN IRIS*

BY

IDA C. MANN

ALTHOUGH the formation and growth of the iris has received a good deal of attention from embryologists and others, there are still some details of the subject which may be regarded as controversial. The following fairly complete series of stages of iris development in the human eye is described with the idea that such an account may be of value, even if only in confirmation of existing views on the subject. All the stages to be described were found in normal human embryos ranging in size from 4.5 mm. (3 weeks) to full term. It is not intended here to attempt to explain how congenital abnormalities of the iris might arise, though many of the stages are suggestive. This aspect of the subject has already been touched upon in a previous paper. The material utilized for the investigation falls into three groups according to the method of preparation. In the first group can be included all the embryos up to the fourth month. These were invariably embedded whole in paraffin and cut into serial sections of 10μ. In the second group are the foetuses of the fourth month and older which are too large to be sectioned whole, and in which the orbital contents have been removed, with or without previous injection of the carotid artery with Indian ink, and embedded and cut by themselves. The third group consists of specimens of the pupillary membrane in foetuses of five months and onwards. To obtain these the eye, after fixation in 10 per cent. formol saline and careful removal of the cornea with a keratome, was fixed by means of gelatine hardened in formalin, in a small glass cell having one plane side through which the pupillary membrane, iris and lens were examined with the Gullstrand slit-lamp and binocular microscope. In this way a much better idea of the gross arrangement of the vessels and also of the extreme delicacy of the membrane can be obtained than by means of paraffin sections.

The story of the development of the iris is essentially that of the forward growth of the margin of the optic cup and the differentiation of the anterior part of the mesoderm in which the whole cup is embedded. There is until after the third month no true iris, although of course the margin of the cup can be distinguished as soon as invagination of the primary optic vesicle has occurred. The complete iris (consisting of a mesodermal stroma backed by ectoderm derived from the optic cup) does not begin to appear till comparatively late, *i.e.*, about the fourth month. A study of its

*Work done under a grant from the Medical Research Council.

development must, however, begin with a stage considerably younger than this, since certain of the mesodermal constituents of the definitive iris appear very early indeed, long before the margin of the optic cup shows any sign of forming the *pars iridica retinae*. The first portion of the iris to become recognizable is the mesodermal stroma with its blood-vessels and of these the so-called "annular vessel," which occupies the position of the future *circulus arteriosus iridis major* is the first to appear. The beginnings of this blood channel can be recognized as early as the 5 mm. stage (4th week), and it has formed an almost complete circle in the 10 mm. stage (5th week). After the appearance of the anterior chamber at 18 mm. (7th week) the rest of the mesodermal stroma and pupillary membrane can be recognized and later the ectodermal layers grow forward deep to this stroma. The muscles of the iris appear last, between the fourth and fifth months, and are developed from the ectoderm. We can, therefore, divide the development of the iris into stages, thus:

1. The stage before the appearance of any iris (mesodermal or ectodermal) but during which the annular vessel becomes distinguishable (4th to 7th week).
2. The stage of differentiation of the mesodermal portion of the iris with the formation of a definite anterior chamber (7th to 11th week).
3. The stage of commencing growth of the ectodermal portion of the iris (11th to 12th week).
4. The stage of differentiation of the ectodermal iris with the formation of the pupillary musculature (3rd to 8th month).

These stages will now be illustrated by a description of typical specimens, some of which are from embryos in the collections of Professor Frazer, of St. Mary's Hospital Medical School, and of Dr. Gladstone, of King's College, who have kindly allowed me to work on them.

The first stage is illustrated in Figs. 1 and 2. Fig. 1 represents a reconstruction model of the optic cup of a fourth-week human embryo. Invagination of the primary optic vesicle has commenced and the lens thickening (which is not shown in the model) is in contact with the invaginated portion of the cup, except below, in the region of the choroidal fissure, where mesoderm is beginning to grow in and separate the two. Otherwise the cup is surrounded by undifferentiated mesoderm. In this, below the cup and along the inferior surface of the optic stalk (the region of the choroidal fissure) primitive blood-vessels, consisting of endothelium-lined spaces containing nucleated red blood cells, can be seen forming. These form channels which anastomose freely, but which are aggregated in the main in three areas:

1. Below, where there is a large vessel (V) a branch of which (H) is becoming included within the lips of the closing choroidal fissure, *i.e.*, the primitive hyaloid vessel, and

2 and 3 on either side of the fissure along the margins of the optic cup, which are being vascularized by upward growing branches from 1 (CI). These upward growing branches are the earliest recognizable annular vessel, not yet of course anything like a complete circle.

Fig. 2 shows a front view of a model of the eye of a 10 mm. (5th week) human embryo. The lens is not shown. It will be

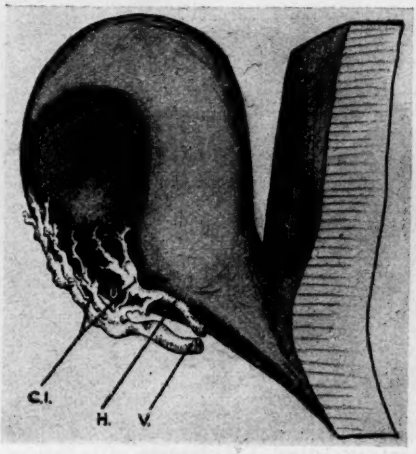


FIG. 1.

Model of optic cup of 4th week human embryo. V=blood vessel giving off H, the primitive hyaloid vessel. CI=branches of V and H vascularizing the margins of the cup.

seen that invagination of the cup has progressed and that the choroidal fissure is closed except for a small portion at the pupillary margin. The blood-vessels seen in Fig. 1 have grown upwards on either side of the cup and have at this stage formed a vascular circle complete except for a small region (A) at the upper part of the cup, where the two channels have not yet met. This vascular circle can now be considered as a definite *circulus vasculosus* occupying the site of the future *circulus arteriosus iridis major* and its vascular connections can be clearly recognized. These are arranged in two sets: (1) a series of channels (CH) connecting the circle with the general choroidal network which now entirely surrounds the optic vesicle—these channels possibly representing the anastomosis in the adult between the circulus and the anterior

ciliary arteries, and even at this stage more marked at the inner and outer sides of the pupil than elsewhere, although as yet none of the blood channels are sufficiently differentiated to be recognizable as distinct arteries or veins—and (2) a small number (in this specimen three) of fine channels (IH) connecting the circle with branches of the hyaloid vessel around the equator of the lens. These vessels I have called "irido-hyaloid." They are the vessels which later form the lateral or capsulo-pupillary portion of the *tunica vasculosa lentis*. They run in a very fine connective tissue meshwork which connects the mesoderm which has now grown in between the lens and the surface with that which has passed into

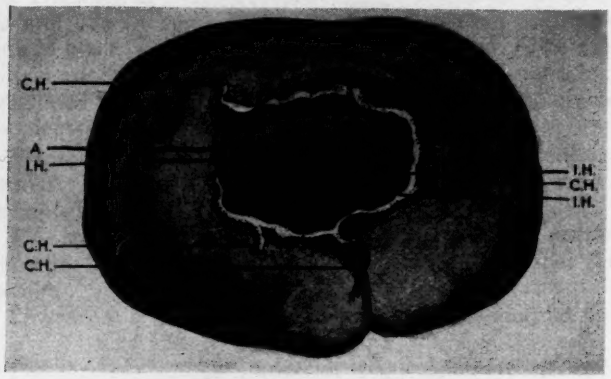


FIG. 2.

Model of optic cup of 5th week human embryo. A= portion of margin of optic cup not yet vascularized. CH=branches of the circulus arteriosus iridis major anastomosing with choroidal vessels. IH= irido-hyaloid vessels.

the interior of the optic cup with the hyaloid artery. This mesoderm surrounding the lens can be distinguished before the 10 mm. stage, but it does not at first contain blood-vessels (except behind the lens). The irido-hyaloid vessels begin to appear about 10 mm. At this stage then we have an eye without any iris or anterior chamber, but with a definite annular vessel anastomosing with anterior choroidal vessels. This stage ends with the earliest appearance of the anterior chamber at 18 mm. (six weeks).

The irido-hyaloid vessels increase rapidly in size and number after the 10 mm. stage, so that at the 26 mm. stage (8th week) they form a continuous series curling round between the margin of the optic cup and the equator of the lens (the lateral portion of the *tunica vasculosa lentis*). At its first appearance, as can be seen in Fig. 2, the annular vessel lies along the extreme periphery of the optic cup and indeed often just within it. Since in the

definitive condition the *circulus arteriosus iridis major* lies at the base of the iris, it is obvious that at least up to the eighth week there is no true iris, the anterior margin of the optic cup only reaching just beyond the equator of the lens, namely, as far as the situation of the future ciliary region. The pupillary end of the choroidal fissure closes before the eighth week and the irido-hyaloid vessels, curling over the margin of the cup, persist well into the tenth week, so that development of the ectodermal layers of the iris (those from the margin of the optic cup) does not really

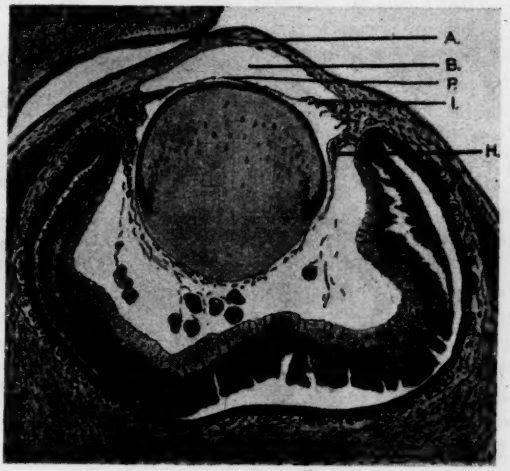


FIG. 3.

Section of eye of 7th-8th week human embryo. A=mesoderm of cornea. B=Anterior chamber. H = mesoderm carrying irido-hyaloid vessels. P=pupillary membrane. I=mesodermal iris.

commence until the third month. The mesodermal parts are by this time well differentiated, as can be seen by considering the figures illustrating the second stage of iris development (Figs. 3 and 4) which begins with the formation of the anterior chamber.

After the separation of the lens vesicle from the surface ectoderm the mesoderm surrounding the optic cup grows in between the two so that at 15 mm. there is a homogeneous mass of mesoderm between the lens and the surface epithelium. At 18 mm. (six weeks) a sort of vacuolation takes place in the centre of this mesoderm, leading to a splitting of it into two parts, an anterior and a posterior. The anterior remains in contact with the surface ectoderm and forms the *substantia propria* of the cornea, and the posterior remains in contact with the anterior surface of the lens

and the anterior margin of the optic cup, being of course continuous with the mesoderm of the irido-hyaloid vessels passing into the interior of the cup between the two. The space between these two portions of mesoderm is the anterior chamber, and it soon becomes lined by endothelium, which extends over the posterior surface of the anterior layer and the anterior surface of the posterior layer, so that at first the anterior chamber is a completely closed space bounded in front by the cornea and behind by the mesoderm in front of the lens (*i.e.*, the pupillary membrane and the mesodermal iris).

FIG. 4.

Section of anterior part of eye of 10th-11th week human embryo. C=fold in ciliary region.

The 26 mm. (7th to 8th week) embryo shown in Fig. 3 shows this condition. A represents the mesoderm of the cornea and B the anterior chamber. The posterior boundary of this must be described in more detail. The margin of the optic cup reaches to just in front of the equator of the lens. The mesoderm at the anterior margin of the cup can be arbitrarily divided into two portions, firstly, a portion carrying the irido-hyaloid vessels (H) and curving round the margin of the cup to blend with the mesoderm surrounding the hyaloid artery, and secondly, the portion passing across in front of the lens, forming the posterior boundary of the anterior chamber. This portion is much thinner in the middle (P) where it is in contact with the lens, than at the sides (I). The middle portion is that part of the anterior vascular capsule of the lens which forms the pupillary membrane and subsequently disappears; the lateral portions (I) thicken and persist as the meso-

dermal stroma of the iris. The backward prolongation of this carrying the irido-hyaloid vessels (H) disappears in order to allow of the forward growth of the ectoderm of the optic cup deep to (I) to form the *pars iridica retinae*. In passing one may note that the *tunica vasculosa lentis* is complete at this stage. It is formed posteriorly by the branches of the hyaloid artery, laterally by the anastomosis of these with the irido-hyaloid branches of the annular vessel, and anteriorly by the mesoderm which will later form the iris stroma and pupillary membrane. There is no *tunica vasculosa lentis* apart from these structures, nor is there any iris *anlage* separate from the antero-lateral portion of the *tunica vasculosa lentis* (I).

At the eighth week, then, the mesodermal iris is well formed. Its three portions (P, I, and H) can be seen in Fig. 3. Of these H begins to retrogress before the eleventh week (48 mm.), and has disappeared completely by the twelfth week (56 mm.); P remains longer and disappears during the eighth month, while I persists.

The third stage is shown in Fig. 4. This shows a section through the anterior part of the eye of a 48 mm. embryo. Just before the complete disappearance of the irido-hyaloid vessels increased growth of the margin of the cup occurs, and the first effect of this is a slight puckering of the margin in the region of the future ciliary processes (C). The irido-hyaloid vessels then rapidly disappear and the margin of the cup grows forward deep to the lateral portion of the mesodermal iris, so that in successive stages after this the *circulus arteriosus iridis major* is seen to lie further and further behind the margin of the cup as the ectodermal iris forms in front of it. This is seen in the diagram, Fig. 5, which is self-explanatory. Note the relative positions at the different stages of the major circle and the edge of the optic cup. The stage of retrogression of the irido-hyaloid vessels and growth of the primitive ectodermal iris is almost complete by the fourth month. Fig. 6 shows a three months' eye. It will be seen that both the mesodermal and ectodermal irides are present, the latter not having reached its full size.

The differentiation of the *circulus arteriosus iridis major* as a definitely recognizable artery appears to occur between the fourth and fifth months. A certain amount of controversy has taken place as to whether there occurs a direct transformation of the annular vessel into an artery (Fuchs, Speciale-Cirincione and Seefelder) or whether the definitive *circulus arteriosus iridis major* is a new vessel arising as a secondary anastomosis between the terminal branches of the long ciliaries and occupying the position of the disappearing annular vessel (Versari). In either case it can be granted that the site of the annular vessel corresponds with the site of the definitive *circulus arteriosus iridis major*.

The fourth and last stage concerns the completion of the ectodermal iris with the formation of the *sphincter* and *dilatator iridis* from it, and the final differentiation and elaboration of the mesodermal iris into the various layers of vessels of the iris stroma.

To deal with the ectodermal iris first—this grows forwards deep to and in contact with the mesodermal iris until the fifth month. After that time the growing tip is not in contact with the mesoderm

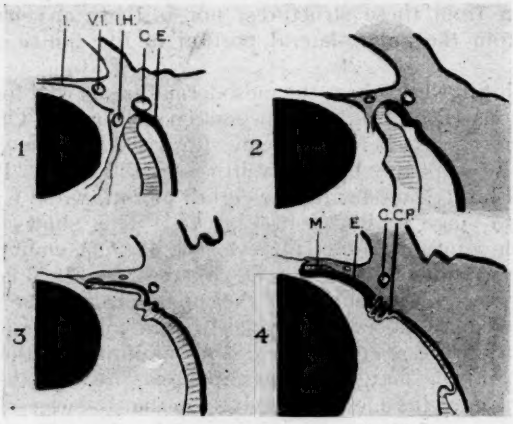


FIG. 5.

Diagram showing four stages in the growth of the iris. 1. Stage of mesodermal iris only. I = mesodermal iris. VI = vessel in mesodermal iris. IH = irido-hyaloid vessel. C = circulus arteriosus iridis major. E = ectoderm of optic cup. 2. Commencing growth of ectodermal iris. The tip of this now reaches beyond the arterial circle. 3. The irido-hyaloid vessels have disappeared and the growing tip of the ectodermal iris is beginning to differentiate. 4. The iris is almost complete. M = sphincter pupillae. E = pars iridica retinae. C = circulus arteriosus iridis major. CP = ciliary processes.

but a little behind it (see Figs. 9 and 10) so that although a little mesoderm is carried with it, the original mesodermal iris (now the fast vanishing pupillary membrane) appears to come off from the anterior surface of the iris and not from its free border. (This condition is of course very well seen in clinical cases of persistent pupillary membrane.) There is no sign of any splitting of the iris stroma into a superficial and a deep layer peripheral to the position of the lesser circle at this stage. Any such appearance seen in the adult appears to depend on the extent to which atrophy of the vessels concerned in nourishing the pupillary membrane spreads towards the periphery.

At the end of the third month differentiation of the ectodermal iris commences and this differentiation of the anterior and posterior layers continues *pari passu* with the forward growth of the whole ectodermal iris. The changes which occur in the posterior layer are the simplest and will be dealt with first. At the third month, as will be seen from Fig. 6, the posterior or internal layer of the cup at the growing edge is composed of columnar unpigmented cells arranged in a single row. At the extreme edge, just where the internal layer turns outwards to become the external layer the cells become cubical and a few granules of pigment appear at the

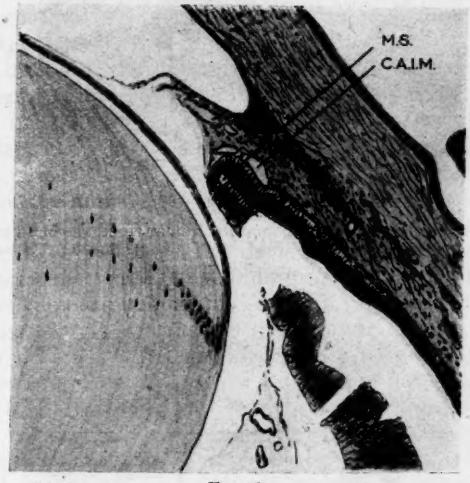


FIG. 6.

Section of the region of the developing iris in a 3 months' human embryo. MS = marginal sinus. CAIM = circulus arteriosus iridis major.

edge. The marginal sinus, the space between the two layers of the optic cup, can be seen at the edge of the cup. This definite circular channel does not appear in the younger eyes, the two layers of the cup being everywhere separated by a space, which in some preparations appears wide and in others narrow. This space in Fig. 3 is seen all round the cup. In Fig. 4 it is wider and beginning to narrow towards the edge, while the first suggestion of a marginal sinus is seen in Fig. 6; in spite of the fact that in this specimen the inner layer was in places torn away from the outer, a definite marginal sinus is seen. It is at first very small, but increases in size as the iris grows, so that at five months—the period of most active growth and differentiation of the edge of the

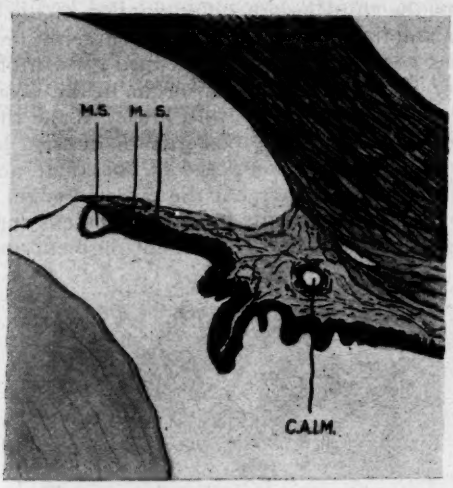


FIG. 7.

Low power view of the iris of a 5 months' human foetus. MS = marginal sinus. M = developing iris musculature. S = pigment spur. CAIM = circulus arteriosus iridis major.

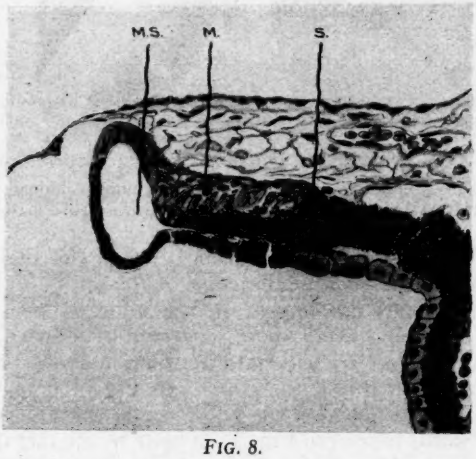


FIG. 8.

High power view of the iris of a 5 months' human foetus. Lettering as in preceding figure.

cup—it is very large (Figs. 7 and 8). After this it gets smaller and has disappeared by the seventh month when growth is slowing down again. The persistence of this portion of the original cavity of the primary optic vesicle for so long appears to be correlated with the late differentiation of the iris and is probably the expression of the rapid change of shape, size, and position of the growing edge whereby cohesion between the layers is rendered more difficult than in the more firmly established retinal area. The pigment appears gradually to spread from the outer layer round the edge of the cup, so that by the fifth month the cells of the deep (inner) layer of the iris are pigmented more than halfway to the base of the ciliary processes. By the seventh month the pigmentation involves both layers of the whole of the iris. This arrangement of the pigment together with the wide open marginal sinus and the differentiation of the outer layer about to be described possibly suggests that growth is taking place almost entirely in the outer layer and that, as the iris comes into being, the redundant outer layer is turned over the edge and becomes the pigmented inner layer, rather than that the cells which were originally of the inner layer should develop pigment in themselves *de novo*.

The outer layer of the iris at the third month is composed of a single layer of epithelial cells containing pigment. In the earlier stages these cells are cubical and contain pigment granules which are, even in Fig. 3, seen to be more numerous in the deeper portions of the cells. At the third month it can be seen that the cells of the outer layer are rather more columnar near the margin of the cup than elsewhere and that the aggregation of pigment in the deeper parts is still more marked. Between the third and the fifth months a remarkable change occurs in the cells of the anterior layer at the growing tip. Their outer unpigmented portions elongate, divide and give rise to a small mass of non-pigmented sparsely nucleated protoplasmic elements (M in Figs. 7 and 8), which lie in front of the pigment layer and later form the unstriped muscle fibres of the *sphincter pupillae*. (With regard to the dilatator fibres these probably come from the same mass. They are very difficult to recognize, but there is some evidence to show that they are part of the original muscle mass (M in Fig. 8), and that they grow peripherally outwards as a thin layer close to the anterior layer of the epithelium.)

The extent of the sphincter muscle mass peripherally is always shown by a spur-like projection of the pigment layer (S in Figs. 7, 8, 9, and 10). The area from which growth of the fibres is actually taking place is unpigmented and forms the anterior wall of the marginal sinus. At first (Fig. 8) the muscle rudiment is in close contact with the pigment layer and little projections and scattered

grains of pigment can be seen extending into it. It is solid and contains no blood-vessels or other mesodermal derivatives. Later it becomes broken up into definite bundles of unstriped muscle by the penetration of a mesodermal stroma into it and vascularized by

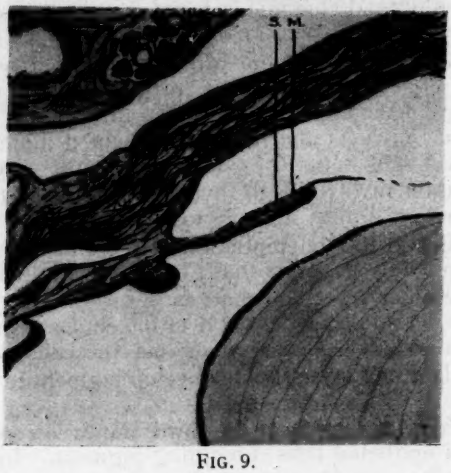


FIG. 9.

Low power view of iris region in a 7 months' human foetus. M=sphincter pupillae. S=pigment spur.

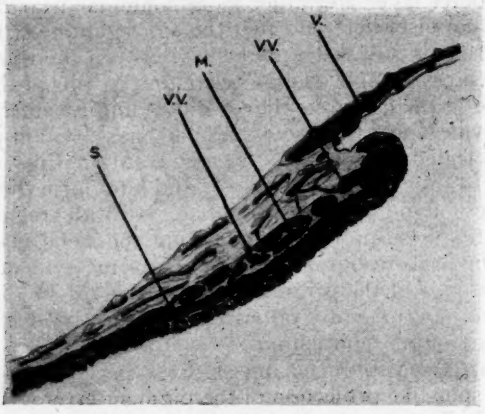


FIG. 10.

High power view of a portion of the iris of a 7 months' human foetus. V=large vessel in pupillary membrane. VV=branches of the vessels of the iris stroma vascularizing the pupillary muscles. M=the pupillary musculature. S=pigment spur.

capillaries which grow out from the vessels in the mesodermal iris. Fig. 10 shows a portion of a seven months iris in which the blood-vessels have been injected with Indian ink. The vessels growing into the muscle mass are well shown (VV). The large vessel (V) is running in the pupillary membrane, which now appears to come off from the front surface of the iris as already described. To pass from this stage to the definitive condition only requires the disappearance of the pupillary membrane. The changes which occur in the mesodermal iris do not include the formation of a new layer, but consist in a richer vascularization of the thick peripheral

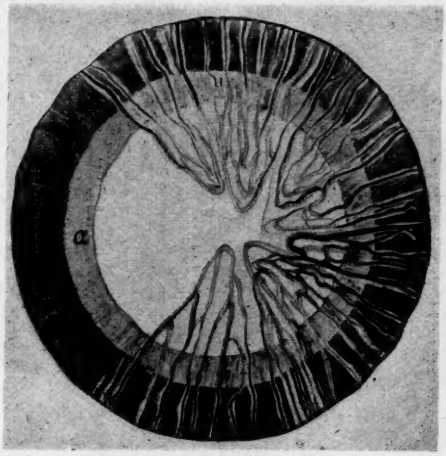


FIG. 11.

Surface view of iris of 5½ months' human foetus (examined with Gullstrand Slit-lamp). *a*=sphincter iridis.

portion, the central portion or pupillary membrane at the same time undergoing atrophy.

At five and a half months the anterior segment of the eye presents the appearance shown in Fig. 11. It will be seen that the relatively narrow ectodermal iris (in which can be distinguished a central paler, sphincteric region and a darker peripheral portion) is overlaid by a very vascular mesodermal membrane which extends over and almost occludes the pupil. At this stage the blood column can be easily seen in the vessels. In the drawing, only three of the four segments of the membrane are represented as the fourth was torn in making the preparation. The arrangement in broad based loops which approach the anterior pole of the lens and turn back again is well known. The vessels at this stage are all almost on the same

level and there are not many anastomoses or deep branches. From this stage onwards there occur increasing anastomosis and branching of the peripheral portions of the vessels together with fresh ingrowth of vessels from the ciliary region, so that one can recognize in injected sections (of the seventh month and after) the condition seen in Fig. 10, already described by Versari, and classified into the following groups of vessels (see also Fig. 12 from Versari).

1. Superficial large vessels of pupillary membrane.
2. Vessels of middle stratum of iris.

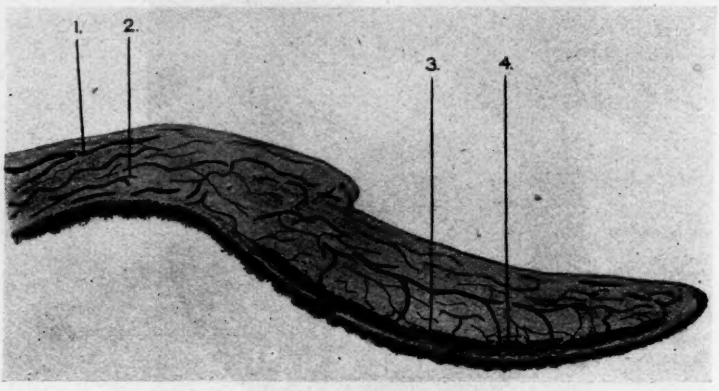


FIG. 12.

Diagram from Versari showing layers of vessels in iris. 1=superficial vessels of peripheral part of pupillary membrane. 2=middle layer of vessels. 3=inter-sphincteric plexus. 4=sub-sphincteric plexus.

3. Inter-sphincteric plexus of radial and antero-posterior vessels in substance of sphincter.
4. Sub-sphincteric plexus between sphincter and epithelium.

It will be noticed in Fig. 11 that the vessels of the pupillary membrane are large and extend in several tiers of arcades (usually three) towards the centre of the pupil which they do not quite reach. The lesser circle of the iris is not yet obvious, but its situation corresponds with the third or most peripheral of the anastomotic arcades, which at present, however, lies just beyond (central to) the edge of the ectodermal iris. The two central sets of arcades represent the parts of the vessels which will atrophy, the third tier will remain to form the lesser circle and the vessels peripheral to this as the large superficial vessels of the iris stroma. That this is happening is apparent in the front view of the iris of the seven months' foetus shown in Fig. 13. It will be seen that

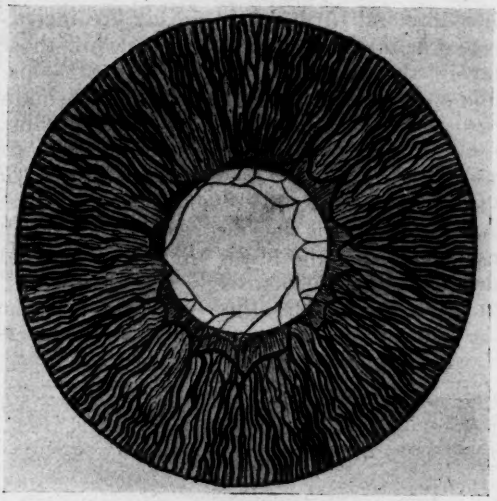


FIG. 13.

Surface view of iris of 7 months' human foetus (examined with Gullstrand Slit-lamp).

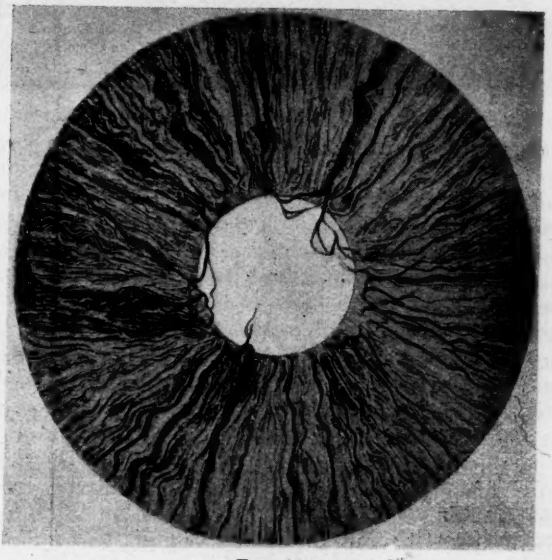


FIG. 14.

Surface view of iris of 8½ months' human foetus (examined with Gullstrand Slit-lamp).

the vessels peripheral to the third arcade are increasing rapidly in number and maintaining their large size while those of the first and second arcades, which in Fig. 11 formed loops practically covering the anterior surface of the lens, are shrinking, receding from the centre of the pupil and rapidly atrophying, though at this stage they still contain blood. The ectodermal iris has grown forward deep to the pupillary membrane to just beyond the third anastomotic arcade, so that this is now clearly recognizable as the *circulus iridis minor*. It is thus clear, as has so often been pointed out by anatomists, that the lesser circle is not an arterial circle, but an arterio-venous anastomosis.

By eight and a half months (Fig. 14) most of the central loops of the pupillary membrane have atrophied and the lesser circle is

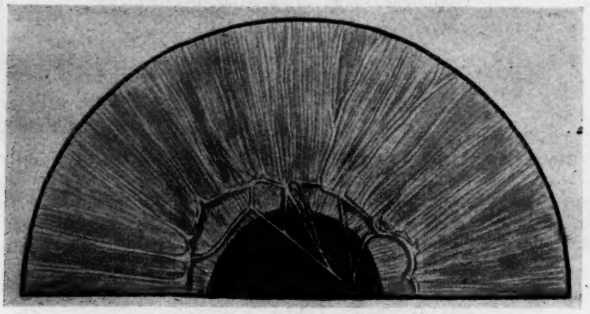


FIG. 15.

Surface view of iris of full term human foetus (examined with Gullstrand Slit-lamp).

established as the sole channel of return of the blood reaching the central portion of the iris by way of the superficial vessels of the stroma. In places the remnants of the first and second arcades still contain blood. The vessels of the iris stroma have increased still further in number and complexity. Since the persistence of the third arcade as the lesser circle provides a free channel for the circulation of the blood in the peripheral portion of the pupillary membrane this peripheral portion does not usually undergo any atrophy, but the vessels of it continue to form throughout life the large thick-walled superficial vessels of the iris. The exact amount of atrophy of this superficial layer varies very considerably in the individual. In Fig. 15 is shown a portion of the iris of a full term foetus with the superficial layer of the iris complete up to the lesser circle, from which come fine strands (without any circulating blood) representing a few persisting remains of the central

loops of the membrane in Fig. 11. In Fig. 16 a portion of the iris of a man of 65 years of age is seen, in which the condition is similar, only without any strands coming from the lesser circle. This is the usual condition in the adult. In some cases the atrophy of the superficial layer may spread in places peripheral to the lesser circle giving rise to an appearance of pits in the iris, the so-called "Fuchs' clefts." The development of pigment in the stroma of the iris occurs after birth and to a very variable extent. In Fig. 16 are seen three small patches of pigment anterior to the vessels. In deeply pigmented eyes an extensive deposit takes place in the superficial layers; so that the details of structure may be entirely hidden. It must be realized that the so-called "sculpturing"

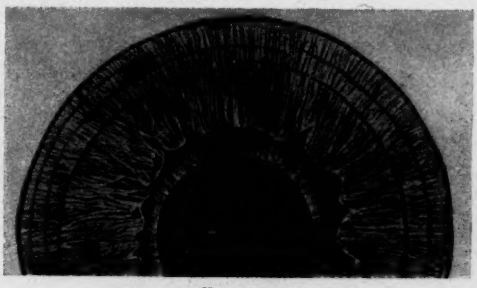


FIG. 16.

Surface view of iris of man of 65 (examined with Gullstrand Slit-lamp).

of the iris seen in life in blue and grey eyes is due to the visibility of the vessel walls and occasionally, under magnification, of the blood column itself, the intervening stroma being quite transparent (though not "optically empty" to the narrow beam of the slit-lamp). In brown eyes the stroma is no longer transparent and the vessels cannot be seen, except those which may be in relief on the surface. In light blue eyes with good illumination and magnification of twenty-four it is often possible actually to make out two or sometimes three layers of vessels which may cross at acute angles, the deeper ones running to the pupillary margin, the superficial ones anastomosing at the lesser circle.

Summary

1. The development of the iris can be divided into four stages:

(1) Fourth to seventh week, before formation of anterior chamber or ectodermal iris, during which stage the annular vessel is formed at the site of the future *circulus arteriosus iridis major*.

(2) Seventh to eleventh week, when, with the appearance of the anterior chamber, the mesodermal iris is formed.

(3) Eleventh to twelfth week, in which the ectodermal iris first makes its appearance.

(4) Third to eighth month, during which the pupillary musculature is formed from the ectodermal iris, and the central part of the mesodermal iris (up to the lesser circle) atrophies, leaving the pupil clear.

2. The definitive iris shows—

(1) A peripheral portion consisting of the entire thickness of the original mesodermal iris plus the ectodermal iris and bounded internally by the *circulus iridis minor*.

(2) A central portion consisting of a thinner layer of mesoderm carried forward secondarily by growth of the ectodermal iris and from the front of which the original central part of the mesodermal iris (pupillary membrane) has disappeared.

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INSTANTANEOUS STEREO-PHOTOGRAPHY OF THE ANTERIOR SECTION OF THE EYE WITH CONSIDERABLE MAGNIFICATION

BY

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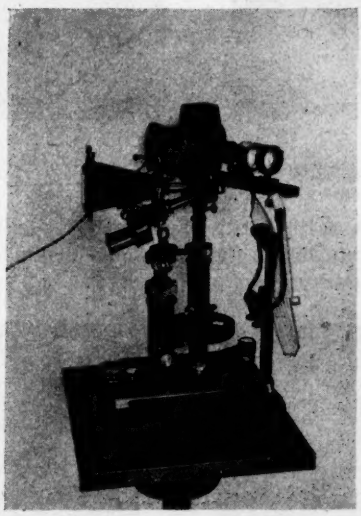
ON account of the constant movement, particularly of the diseased eye, and of the minuteness of the morbid changes, their photographic reproduction is attended by considerable difficulties. The ideal camera for the purpose is a stereo-camera giving considerable magnification, capable of rapid and easy adjustment and of working with an exposure of, at the utmost, no more than 1/25th second. One of the best instruments available is the mirror reflex camera

of Lenz[1]. This instrument is, however, complicated and expensive and for general purposes the stereo-camera of Druener[2] is to be preferred. With this camera there is the difficulty that after the image has been focussed on the screen this has to be removed and replaced by the plate holder and the shutter set for instantaneous exposure. Although these manipulations take but a few seconds there is always the danger of movement of the eye, specially in the case of nervous and light-shunning patients. Further, the objectives used are of low light power so that the necessary short exposures do not yield properly exposed plates even with low magnifications.



In the combination described below (see text figure) these difficulties have been overcome by fitting the stereo-camera to a binocular corneal microscope. The camera is mounted immediately above the microscope and it is essential that the angle formed by their axes should be as small as possible. In the original camera of Druener the shutter is an obstacle to this arrangement because of its size and of the position of the release, coming as it does between camera and microscope. For this reason the shutter has been modified and the release brought to one side. The camera is mounted on rack and pinion to allow of lateral and vertical movements and can be clamped in any desired position by means of a screw; it is thus easily centred with, and adjusted to the focus of, the microscope for each combination of lenses used. It is of

course to be understood that any alteration of objectives at either camera or microscope necessitates re-adjustment of the camera. The camera so fixed follows all the movements of the microscope, thus ensuring that an object sharply focussed in the latter is equally

FIG. 1.

Infiltratio cornea phlyctenulosa. Magnified 1.7 diam. Taken with objective F=55. Contrast with Fig. 2.

sharply focussed in the former. To avoid blurring of the image the camera is arranged so that the plate lies as far as possible in the plane of the iris.

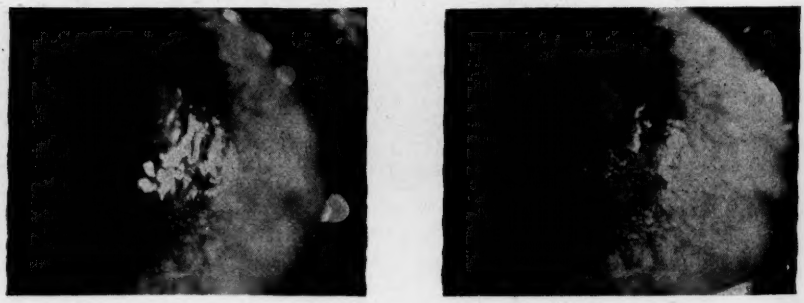


FIG. 2.

The same picture magnified 4.1 diam. Taken with objective A2.

As the field of vision through the corneal microscope is less than that through the camera, only the central portion is viewed of what will appear on the photographic plate. This, however, is no objection to the apparatus but rather the reverse, as it permits very accurate focussing of the centre part of the object since this is seen through the microscope stereoscopically, much enlarged and brightly illuminated.

For illumination the most suitable source is the micro-arc lamp with quartz condenser and cuvette supplied by Zeiss for slit-lamp microscopy, etc. Mounted on the movable arm of the Zeiss instrument table it allows of easy and rapid

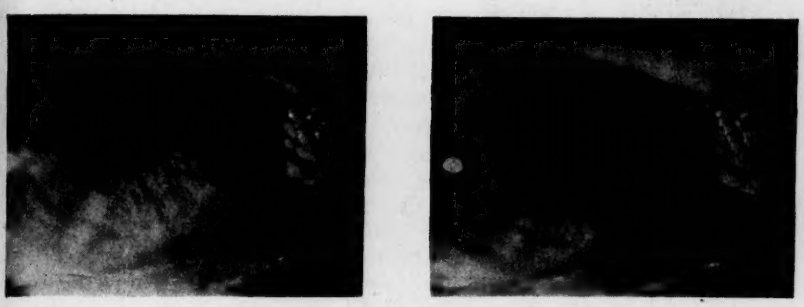


FIG. 3.

Papilloma of upper lid magnified 4.1 diam. Taken with objective A2. Note the detail of the dark brown iris.

adjustment of the illumination. In order to avoid the dazzling of sensitive patients a grey disc or a geaphot filter may be inserted during focussing. The eye to be photographed does not as a

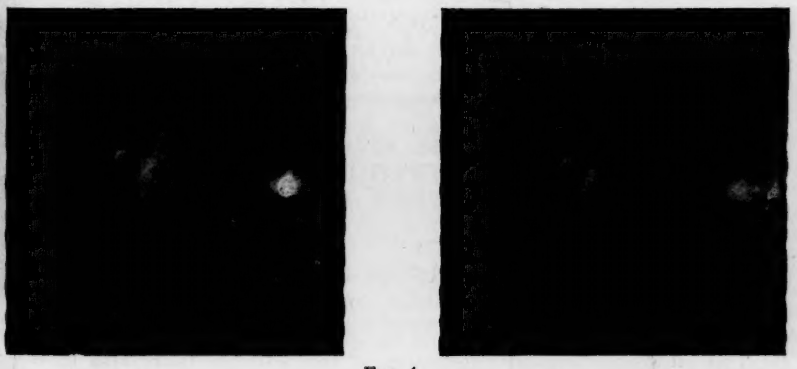


FIG. 4.

Cataracta pyramidalis magnified 4.1 diam. Taken with objective A2.

rule require any preparation, nevertheless, it is advisable before making the exposure to instil a drop or two of cocain or diocain. The procedure for taking a photograph is as follows: The camera being centred and adjusted to the focus of the microscope, the focussing screen is removed and the plate holder inserted. The shutter is set for instantaneous exposure and the dark slide with-

drawn. The patient's head is fixed in the usual manner for microscopical examination and the illumination adjusted. All that remains to be done is to focus the desired portion of the eye in the microscope, remove the filter from the lamp, and make the exposure.

By this arrangement one can obtain with certainty and ease excellent photographs enlarged either 1.7 or 4.1 diameters—the latter by using A2 objectives. With the fourfold magnification even dark brown irides are clearly shown in sufficient detail (see Fig. 3). Using the A2 objective, the 6 by 6 cm. plate is not large enough to reproduce the whole eye and its appendages, but this magnification is very valuable when dealing with minute changes on the bulbus oculi, specially on the cornea, iris, and pupil, which cannot be made out with the usual magnifications. The camera mounting does not interfere with the use of the corneal microscope for other purposes and in any case it may easily be removed. In the same way the Zeiss lamp can be used either alone or in combination with other instruments.

It is considered that the above described apparatus has several advantages over the Lenz camera and specially in that perfectly sharp fourfold magnified photographs can be obtained with ease and certainty; moreover, the apparatus is comparatively cheap.

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OBSERVATIONS ON THE HYDROGEN ION CONCENTRATION IN THE VITREOUS BODY OF THE EYE WITH REFERENCE TO GLAUCOMA

BY

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THE physico-chemical conditions of the vitreous body and their alterations under pathological conditions are almost unknown. As human material is scarcely to be obtained in the requisite quantity without injury to the eye, the existing scant knowledge is founded chiefly on animal observations. This is specially true with regard to the pathogeny of glaucoma. Fischer[1] attempted to explain this condition, but on somewhat slender grounds, as an oedema determined by a disturbance of the acid-base equilibrium in the vitreous body due to an increase in the acid content of the

eye media. Meesmann[2] examined the aqueous humour from this point of view and found its Ph increased, but he supposed the heightened tension of the eye to be brought about by constriction of its efferent vessels, the vitreous remaining inactive. The present observations have been directed to the estimation of the hydrogen ion concentration of the vitreous body in various cases of primary and secondary glaucoma and in a number of controls.

The hydrogen ion concentration has been estimated by the Michaelis[3] colour indicator method, unbuffered and using m-nitrophenol as the indicator. The necessary quantity of vitreous was aspirated from the eye by a sterile dry syringe and an accurately measured quantity of 0.5 c.c. was placed in a Jena glass test-tube. To this was added 0.3 c.c. of 0.3 per cent. m-nitrophenol, and physiological saline to make up 3 c.c., the test-tube being then closed with a paraffined rubber stopper. The tint of this solution was measured in a Walpole's comparator against a series of standard tints as described by Michaelis, and the Ph calculated by the formula $Ph = Pk + \log \frac{b}{1-b}$ where b is the degree of colouring (Farbgrad Michaelis).

The results of these observations are given in the accompanying tables. From Table A it is seen that in five cases (both eyes examined in Case 4) without glaucoma the Ph has been found to vary from 7.40 to 7.52, the average being 7.47. Observations on the normal eyes of healthy rabbits have shown the Ph to lie within the same limits and these observations are in agreement with those of Hertel[4] and Meesmann[2] for the aqueous humour of the anterior chamber, although the protein content of the vitreous is higher. Table B shows that in four cases (Case 2 examined three times) of secondary glaucoma the Ph varied from 7.39 to 7.60, the average being 7.53.

TABLE A. CONTROLS.

Case	Diagnosis	State of eye	Tension mms. Hg.	Ph.	Remarks
1	Atrophia n. optici	Not injected	18	7.44	—
2	Degen. pigm. ret.	,,	21	7.50	—
3	Atrophia n. optici	,,	21	7.44	—
4	Atroph. n. opt. R. eye	,,	26	7.50	—
	Atroph. n. opt. L. eye	,,	26	7.52	—
5	Phthisis bulbi ...	Injected	10	7.40	—
		Average Ph. ...		7.47	—

TABLE B. SECONDARY GLAUCOMA.

Case	Diagnosis	State of eye	Tension mms. Hg.	Ph.	Remarks
1	Leucoma corn. adher.	Injected very little	51	7.57	14 days after iridect. antigl.
2	Luxatio L. in. vitr.	Injected	51	7.54	Untreated
		,,	60	7.60	7 days after first aspiration of vitreous
		,,	28	7.52	7 days after second aspiration
3	Leucoma corn. adher.	Greatly injected	44	7.39	7 days after cyclodialysis of Heine
4	Staphyloma corneae	,,	45	7.57	—
		Average Ph. ...		7.53	

TABLE C. PRIMARY GLAUCOMA.

Case	Diagnosis	State of eye	Tension mms. Hg.	Ph.	Remarks
1	Gl. Infl. chron. ...	Not injected	45	7.64	—
2	,, ,, ...	,,	50	7.60	—
3	,, R. eye	,,	73	7.57	A year after iridect. antigl.
	,, ,, L. eye	,,	63	7.54	,, ,,
	,, ,, R. eye	,,	60	7.60	14 days after first aspiration
	,, ,, ,,	Very little injected	55	7.56	21 days after first aspiration
4	,, ,, ...	Slightly injected	63	7.52	—
5	,, ,, ...	Injected	51	7.57	—
6	Gl. infl. acutum ...	Greatly injected	83	7.56	—
		Average Ph. ...		7.57	

Most interesting, however, are the results in six cases of primary glaucoma (Case 3 examined four times); Table C shows that here the Ph is definitely higher not only than in a normal eye but than in an inflamed eye. The Ph varies from 7.52 to 7.64, the average being 7.57. This increase in the alkalinity of the vitreous can hardly be regarded as a passive change and will not be without

influence on its volume. For, from the physico-chemical point of view the vitreous body belongs to the hydrophil emulsoids and it is known that the degree of swelling of such emulsoids is dependent, among other factors, chiefly on the acid-base equilibrium and that, within certain limits, the lower the hydrogen ion concentration the greater is the swelling. It would seem, therefore, that in the observed increased alkalinity of the vitreous body lies a possible explanation of the increased intraocular tension in glaucoma.

One of the difficulties of the currently accepted explanation of primary glaucoma, as due to diminished outflow through the canal of Schlemm, is that the anterior chamber is not deeper as would be expected but is actually shallower than normal. On the present view, however, a shallow anterior chamber would follow as a natural result from the presence of a swollen vitreous, the swelling being due to an alteration of its acid-base equilibrium, not, however, in the direction of increased acidity as put forward by Fischer, but in the direction of increased alkalinity.

As regards the cause of the disturbance no explanation can be offered at present but it is suggested that more attention should be paid to the blood in glaucoma.

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CHANGES IN REFRACTION ASSOCIATED WITH TRANSIENT GLYCOSURIA

BY

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GLASGOW

As an addendum to the important paper of Dr. W. Stewart Duke-Elder in the April number of the BRITISH JOURNAL OF OPHTHALMOLOGY, the following case may be of interest.

Mr. D.F.C., aged 58 years, a business man of heavy build, came under my care in March, 1923, owing to a defect in the vision of his left eye which his optician was unable to correct with glasses. He had been aware of a defect in this eye for twenty years. Vision (March, 1923) was R.=5/9, L.=5/12, and with correction, 5/5 and 5/6. He gave a "gouty" history, and his eyelids presented several chalazia and conjunctival lithiases. On ophthalmoscopic examination the right eye was found to be normal except for the

presence of a small patch of opaque nerve fibres at the upper nasal border of the disc. The left eye showed an irregularly circular opacity in the central part of the posterior cortex of the lens, and there was a large area of opaque nerve fibres completely surrounding the disc.

In October, 1923, his correcting glasses were:

R. +0.75D.s. ⊂ +1.5D. cyl. axis 45°

L. -0.25D.s. ⊂ +1.5D. cyl. axis 150°

and with these R.V. was 5/5 and L.V. 5/12.

In April, 1924, he complained of a spot before the right eye, and one could now detect a very small spot of opacity in the centre of the posterior cortex of the right lens and one sub-capsular vacuole in the centre of the anterior cortex. The opacities in the left eye were more extensive. Corrected vision was still 5/5 in the right eye and in the left had fallen to 5/18.

Early in December, 1924, he became alarmed on account of a considerable falling off in the vision of the right eye, which uncorrected was now 5/24. Retinoscopy showed that the refraction of the right eye had changed in the direction of increased hypermetropia, and with +1.75D.s. ⊂ +1.5D. cyl. axis 45° vision could be again brought up to 5/5. This correction was ordered but he was asked to retain his old glasses as the change might be temporary. Ophthalmoscopically, the only change was that the lens opacity in the right eye had extended slightly downwards so that it was now a delicate streak rather than a small spot.

On inquiry I found that, on the advice of some friends, he had been drinking large quantities of soda-water with the object of reducing his weight. The result was a reduction of more than a stone in his weight within a few weeks. At the same time he felt ill and suffered from bronchitis and gastric catarrh. Dr. James Stewart, Crosshill, whom he consulted at the beginning of November, 1924, found a considerable reaction for sugar in the urine, and the blood sugar, by McLean's test, amounted to 0.212. The glycosuria, however, disappeared with a slight modification in diet and was not observed again.

Early in January, 1925, he again complained of failing vision, and the right eye had now become less hypermetropic. With +1.25D.s. ⊂ +1.25D. cyl. axis 45° vision was 5/5. One month later the correcting glass was +0.75D.s. ⊂ +1.5D. cyl. axis 45°; that is to say, the refraction had returned to the value found in October, 1923, and the vision of this eye was still 5/5.

The rather sudden increase and diminution of the hypermetropia of the right eye was not accompanied by corresponding changes in the visible structure of the lens. In the left eye, from the date of his first observation, there had been progressive increase in the density of the opacity, and vision, with correction, had fallen

progressively from 5/6 in March, 1923, to "fingers" in February, 1925. No change in the refraction of this eye could be made out.

He was treated at first with local applications of potassium iodide and dionin, and latterly with the Blache ointment of calcium and iodine, but without any apparent modification of the progress of the condition.

HELMHOLTZ'S THEORY OF ACCOMMODATION

BY

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IT is an interesting fact that the three theories which are particularly associated with the name of Helmholtz have all been receiving support as the result of recent experimental work. The trichromatic theory of colour vision, the resonance theory of hearing, and the spherical theory of accommodation one and all fell from popular favour on Helmholtz's death. The attacks of Edridge Green on the trichromatic theory, of Thomas Wrightson on the resonance theory, and of Tscherning on the spherical theory produced effects of undeniable magnitude. Now, however, these attacks have been stayed and the three theories are returning to their orginal popularity.

The history of Helmholtz's theory of accommodation may be briefly stated as follows: As is well known the physical basis of the theory requires that the crystalline lens on accommodation for near objects should become both thicker and smaller in diameter. It is a deduction from the theory that the lens, when removed from the eyeball should be in the fully accommodated state. Tscherning at first questioned every one of these statements, and, in the diagram published in his physiological optics, he showed neither a change in diameter nor in thickness. Many other ophthalmologists repeated Helmholtz's measurements and confirmed them in practically every detail. As a result Tscherning modified his position so that he showed in his diagram exhibited at the Thomas Young Oration, delivered to the Optical Society in 1907, a change in both diameter and thickness. He still held, however, to his original contention that the lens, when removed from the eyeball should be adjusted for distant vision and not fully accommodated as Helmholtz supposed.

Of recent work on this subject a paper by Fincham (*Trans. Optical Soc.*, Vol. XXVI, No. 5, 1924-5) is of great interest. This author, after reviewing the two rival theories in some

detail proceeds to a determination of the optical constants for near and distant vision for the two eyes of two young men, using the most accurate methods at his command. Thus the curvature of the cornea in different meridians was measured by Drysdale's method for the determination of the curvatures of small lenses.

Fincham's principal measurements are summarized in the table given below:

Accommodation.	Case H.		Case M.	
	+1 D.	+9 D.	+1 D.	+9 D.
Anterior surface lens radius = ...	11.62	6.9	12.0	5.0
Anterior chamber depth = ...	3.68	3.34	3.33	3.06
Crystalline lens thickness = ...	3.66	4.24	3.84	4.20
Posterior surface lens radius = ...	5.18	5.05	5.74	4.87

It will be seen that in general the above measurements confirm those of Helmholtz. The interesting facts brought out concern the differences between the two cases M. and H. Whereas in Case H. the anterior and posterior lens surfaces suffer the greatest separation, in Case M. they change most in curvature, for the same change in accommodation. There must, therefore, be considerable individual differences in the details of the changes which bring about accommodation.

As to the details of the changes there is apparently some discrepancy between Fincham's experimental results and the explanation which he advances to account for them. Thus in Fig. 8 he shows for both cases his conclusions with regard to the eye at rest. In both the central part of the anterior lens surface is shown to be flatter than the more peripheral parts. In Fig. 9, on the other hand, is shown diagrammatically the relative capsular thickness at different parts of the lens. The capsule over the anterior surface is thinner at the centre than it is at the more peripheral portions. It is the author's hypothesis (see p. 24) that "if parts of the capsule are weaker they will be distended more readily by pressure from within and will consequently cause the surface to be more steeply curved in these parts. Thicker and stronger parts of the capsule will resist distension and so cause the surface to be flattened. Assuming the Helmholtz theory to be true, the lens in the unaccommodated state is under tension by the zonule fibres which are inserted into the capsule upon the anterior and posterior surfaces at a short distance from the equator.

This tension upon the capsule causes it, when its strength is sufficient, to flatten the surfaces of the lens."

Now, according to Fig. 9, its strength is greater in the periphery than at the centre, and, therefore, on the author's explanation we should expect to find a more curved centre but a flatter periphery. But Fig. 8 appears to show the converse. It should be pointed out that on page 25, line 15, the author says: "the resultant surface would show a greater curvature in the centre than towards the periphery. Such a form was found to exist in the anterior surface of the lens in Case M. in the unaccommodated state." This statement agrees exactly with the author's conclusion. It would seem clear from this that a slip has occurred in the drawing of Fig. 8. If this is the case Fincham's results are in unequivocal agreement with Helmholtz's theory, and with those obtained by Yamada and myself (*Brit. Jl. of Ophthal.*, Vol VI, p. 481, 1922). We found that if the crystalline lenses were removed from the cat's eyes they were in the fully accommodated state, and we concluded also that the peripheral parts of the anterior lens surface suffer a relative but not an actual flattening on accommodation. Both these conclusions are antagonistic to Tscherning's views.

I should like to complete this brief survey by expressing, firstly, my admiration for Fincham's researches, and, secondly, my hope that he will extend his researches to many more cases, not youths alone but also middle-aged. For the precise nature of the lens changes in presbyopia is practically unknown. It seems to me that the time has come to regard presbyopia as a disease and not as a normal physiological process.

ANNOTATION

Lacrymal Obstruction

Thirty years or so ago it was customary to treat our lacrymal cases in general by the old-fashioned method of probing and lavage. It is true that we gave our patients rather a bad time, but cocain was a great help as the following story shows. The writer had been in the habit of regularly passing probes on a working-class woman who habitually said nothing during the process. On only one occasion did she speak, and to the point. What she said was "Ach doctor! you're awfu' coorse the day." The cocain had been omitted. *Hinc illae lacrimae.* To continue, we were not satisfied with probing and there came a time when it was almost

malpraxis to slit the canaliculus or to pass a probe. So we excised the sac, an operation which was often extremely satisfactory not only as regards the removal of a septic focus but also in that lacrymation afterwards was not so troublesome as might be expected. But still we—speaking purely in an impersonal sense—were not satisfied so went a step further and developed various operative procedures to obtain free drainage into the nose. What is the result? At a recent meeting of the Section of Ophthalmology of the Royal Society of Medicine a paper was read by a well-known ophthalmic surgeon on methods of operating in cases of suppurative dacryocystitis. These methods involved the making of an opening through the sac into the middle meatus of the nose. To judge from the report of the proceedings in our contemporary the *Lancet* (June 27, 1925) the proposals were received with what one might almost call a chorus of disapproval.

In order to avoid personalities for the present, we may put it that the voices in the chorus expressed the following opinions: That epiphora must still exist after the operation; that there was danger of a fistula from the nose to the face after the operation; that after West's operation the opening tended to close up and the patient was no better than before; that there was liability to general infection of the ethmoid cells. Have we, as usual, gone too far and must we retrace our steps? The answer is difficult.

ABSTRACTS

I.—ACCOMMODATION

(1) **Fincham, E. F.—The changes in the form of the crystalline lens in accommodation.** *Trans. Optical Soc.*, Vol. XXVI, No. 5, 1924-1925.

(1) The original object of the investigation, so **Fincham** tells us, was to determine the form of the lens in various states of accommodation. It was hoped that from measurements of a number of eyes a set of curves could be plotted which would show the thickness of the lens and the radii of its surfaces for every state of accommodation in the average eye.

A number of preliminary measurements were made upon the radius of the anterior surface of the lens in different eyes, but it was found that this value varied over a wide range for the same condition of accommodation. Two cases were found, both males of the same age and having an equal error of refraction; the

anterior surfaces of the lenses in the two cases were of nearly equal radius when at rest, but behaved quite differently during accommodation. The examination of these two cases forms the basis of the paper.

MEASUREMENT OF THE RADIUS OF CURVATURE OF THE ANTERIOR SURFACE OF THE CRYSTALLINE LENS.

(*a*) *Observation of the surface and its alteration during accommodation.*—The author observed that the convex form of the anterior surface of the lens can readily be seen when illuminated by the slit-lamp. Further, by observing the lens obliquely with the microscope while the beam of the slit-lamp was directed along the optic axis of the eye, its anterior surface could distinctly be seen to increase in curvature when the subject made a large effort of accommodation.

No direct measurements could be made owing to the oblique direction of observation through the peripheral part of the cornea.

Apparently this is the first time that this observation has been made.

(*b*) *Nature of the Images reflected from the Anterior Surface of the lens.*—Fincham found that the distinctness of images formed on the anterior surface of the lens varied a great deal in different subjects, but he found one in whom the images from both the anterior and posterior surfaces of the lens were so distinct that he was actually able to photograph them.

The illumination in this case was obtained by reflecting on the eye the light of a naked arc by means of concave mirrors, giving the effect of three sources of illumination. In order to secure the pupil large enough to exhibit all the images, a shutter was placed in front of the arc lamp, and was released simultaneously with the shutter of the camera. As the length of the exposure was only 1/5th second, it was completed before the light had caused the pupil to contract.

The photograph of the accommodated condition was made whilst the subject was viewing a near object placed upon the original line of sight, so that the direction of the eye was the same in both cases. An ingenious arrangement whereby this was brought about will be explained a little later.

(*c*) *Measurement of the Radius.*—For this a simplified form of Tscherning's ophthalmophakometer was used, details of which need not be mentioned.

The radius of curvature of the cornea was measured with the Javal ophthalmometer.

The two cases selected for study were of the same age, 19 years. The error of refraction was equal in each case, 1 dioptre manifest

hypermetropia, and both were free from astigmatism. There was, however, a difference in the amplitude of accommodation. In the case H, both uniocular and binocular amplitudes were 11 dioptres, while in case M, the uniocular amplitude was 11.5 dioptres and the binocular 13.5 dioptres.

Fixation was secured by directing the subject to look steadily at the centre of a cross scratched in fine lines upon the back of a small mirror. This was placed at the correct distance from the eye for the particular test and was adjusted so that it reflected

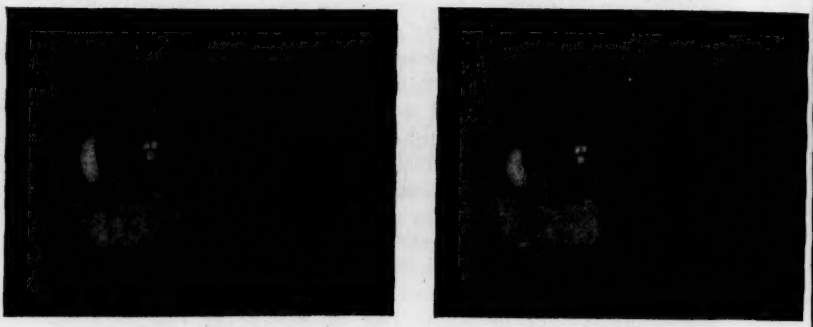

FIG. 1.

On the left is seen the disposition of the images of Purkinjé with the accommodation relaxed, and on the right with an accommodation of 8 dioptres.

to the subject's eye light from a window which was behind his head.

The small mirror with the cross scratched upon the back was used as the fixation object throughout. When it was desired to observe the changes in the lens in the act of accommodation, the mirror was directed so that the image of a distant lamp behind the subject's head was seen by him in the mirror, in line with the centre of the cross. The eye which was not under observation was covered, and the subject was able to accommodate either for the distant lamp or for the surface of the mirror without moving the axis of the eye.

The curves obtained by plotting the measured radii of curvature against the amount of accommodation exercised, showed a considerable difference in the two cases. Beyond about 4 dioptres the case H altered the curvature of the anterior surface of the lens much less than the case M, for an equal amount of accommodation.

THE DEPTH OF THE ANTERIOR CHAMBER.

In the study of accommodation, changes in the position of the anterior lens surface relatively to the cornea are of interest, from two points of view. In the first place a change in the position of this surface will modify the dioptric power of the eye, quite apart from alterations in its curvature, and so must be considered as one of the possible factors in the production of accommodation. Secondly, in considering the problem of the mechanism by which these changes in the lens are produced, the more nearly we can determine the movement of each part of the surface, the more exactly shall we be able to estimate the disposition of the forces which are responsible for the change.

Fincham has made his measurements by means of a combined corneal microscope and slit-lamp of special design, a description of which will be found in this journal (February, 1925). He points out quite properly that the reflected images produced by the surfaces of the lens have rather lost their interest since the introduction of the slit-lamp as we are now able to examine the surfaces themselves.

Direct readings by this method naturally only gave the apparent depth of the anterior chamber, consequently calculations were necessary to find the real depth of the anterior chamber.

He was able to prove the forward movement of the anterior surface of the lens as was originally stated by Helmholtz.

THE FORM OF THE ANTERIOR SURFACE OF THE LENS.

For the purpose of observing the phenomena of the alteration in curvature of the anterior surface of the lenses in the eyes of the two cases (H and M), the pupils were dilated with homatropin and cocain, and the observations were made before any considerable paralysis of the accommodation had become manifest. The illumination was supplied by focussing upon the eye the images of a "Pointolite" lamp produced by five small concave mirrors, which were mounted upon a metal arc held vertically before the eye.

In the case H, when the accommodation was relaxed, the row of images from the anterior surface of the lens formed a straight line close to the edge of the pupil. When the eye accommodated 6D. the row became smaller, but remained straight. It appeared from this observation that in this particular eye the anterior surface of the lens approached closely to the spherical form when at rest, and was not greatly distorted under the influence of accommodation.

The eye of the case M showed a remarkable difference in this respect. While the subject was viewing a distant object the line

of images assumed a marked curve, and when he accommodated 6D. without altering the direction of the visual axis the three central images fell upon a straight line, showing that the portion of the surface producing them was approximately spherical, whereas the images at the two extremes showed a remarkable splaying, characteristic of a reflection from a conical surface.

From these observations it appeared that the anterior surface of the lens in this eye (Case M) in the unaccommodated state varied from the spherical form by a flattening, commencing probably beyond about 2 mm. from the axis. When this eye accommodated, the lens surface took on the form of a shallow cone having its apex rounded into a spherical curve extending over an area about 3 mm. in diameter. Normally only this spherical portion was exposed by the pupil.

THE PERIPHERAL DEPTH OF THE ANTERIOR CHAMBER.

These observations necessitated the determination of the form of the corneal surface through which the observations were made. For this purpose the method suggested by Dr. Drysdale for measuring the radius of curvature of small surfaces was employed.

The peripheral depth of the anterior chamber was then measured with corneal microscope and slit-lamp at a point 1.5 mm. from the limbus. To secure that the light was incident normally to the corneal surface, the instrument was adjusted so that the beam of light reflected back from the cornea fell upon the centre of the projecting lens of the illuminating tube. The microscope was placed close to the illuminating tube so that observation and illumination were made through, as nearly as possible, the same part of the cornea.

INCREASE OF THICKNESS OF THE LENS IN ACCOMMODATION.

In measuring the apparent thickness of the lens in the two cases (H and M) by means of slit-lamp and microscope, it was necessary to consider the cornea and the anterior lens surface as one lens system through which the observations were made. The change in depth of the anterior chamber and the radius of the anterior surface of the lens were taken into account in order to ascertain the power of the combined system in the accommodated state.

In Case H the increase in thickness was 0.58 mm. in passing from 1 to 9D. of accommodation; and in Case M, for the same amounts of accommodation, the figure was 0.38 mm.

MOVEMENT OF POSTERIOR POLE OF LENS.

An increase in accommodation of 8D. was accompanied by a backward movement of the posterior pole of the lens of 0.24 mm. in Case H, and of 0.09 mm. in Case M.

THE RADIUS OF CURVATURE OF THE POSTERIOR SURFACE OF THE LENS.

An increase in accommodation of 8D. produced a change in radius of 0.13 mm. in Case H, and of 0.87 mm. in Case M.

From these results it is seen that, although the posterior surface alters very slightly, its behaviour is similar to that of the anterior surface; that is to say, that in the two cases the surfaces which altered most in radius during accommodation suffered the least movement of their apices. Case H shows the greater movement of both front and back surfaces, whereas, in Case M, the surfaces show the greatest increase in curvature.

CHANGE IN THE EQUATORIAL DIAMETER OF THE LENS.

No conclusive evidence was forthcoming from the examination of a case in which the periphery of the lens was visible along 4 mm. of its extent through an operative coloboma.

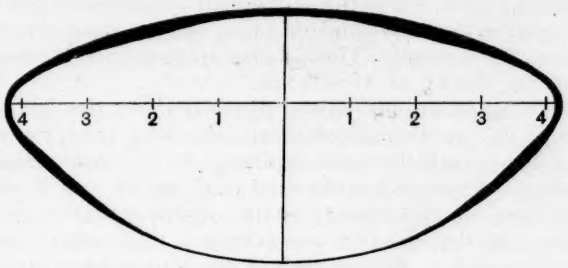

FIG. 2.

A diagrammatic representation of a section of an average lens capsule in which the relative thickness of the capsule is magnified 100 times.

THE LENS CAPSULE.

Fincham draws attention to the well-known elasticity of the lens capsule, quoting some of Bowman's observations.

He then draws attention to an observation by Bowman, but less well known, *that the thickness of the capsule is not uniform*. A table is copied from Salzmann's "Anatomy and Histology of the Human Eyeball," showing the variations in thickness of the capsule, and the appended diagram shows forcibly how very considerable these variations are.

The capsule of the anterior surface has its maximum thickness in a zone 3 mm. from the pole, whereas the capsule of the posterior surface, which is extremely thin over the greater part, reaches its maximum near to the equator of the lens.

Fincham has designed and made a working model of the lens capsule in rubber with thicknesses varying, as they do in the

actual lens capsule. This india-rubber model was suspended by means of thin tapes which were attached to the periphery of both surfaces in such a way that tension could be applied equally and in an approximately tangential direction to the surfaces. Under the influence of tension, both surfaces were nearly spherical, the thinner posterior surface having the greater curvature when the tension was relaxed. The thicker surface assumed a hyperbolic form which was similar to the accommodated condition of the anterior surface of the human lens. The centre of the surface became more steeply curved, while the periphery was flattened. The thinner surface remained practically unchanged in curvature, although the relaxation of tension was equal for both surfaces.

CONCLUSIONS.

In the consideration of the theory of the mechanism of accommodation we must accept the experimental evidence of the increase of the central thickness and decrease of the equatorial diameter of the lens (Grossman). These facts appear to indicate the general truth of the theory of Helmholtz.

Tscherning based his chief objection upon the fact that the surface of the accommodated lens is distorted from the spherical form, a change which is not explained by a simple relaxation of the tension. From a consideration of Cases H and M, it is seen that not only is this change in the figure different in different eyes, but also that the increase in central thickness of the lens is not proportional to the increase in the curvature of its surfaces. In these particular cases it was found that, for an equal increase in accommodation, the surface which suffered the greatest change in curvature showed the least movement of its apex. It was this surface also which showed the greatest variation from the spherical curve in both the relaxed and accommodated conditions. If, then, we are to accept the Helmholtz theory, some factor must be found which will explain the change in the figure of the anterior surface and will also permit the existence of the differences of behaviour in different eyes.

Fincham suggests that this factor is to be found in the combination of the elastic nature and varying thickness of the lens capsule. If parts of the capsule are weaker, they will be distended more readily by the pressure within, and will consequently cause the surface to be more steeply curved in these parts. Thicker and stronger parts of the capsule will resist the distension and so cause the surface to be flattened. He suggests that the resultant lenticonus may be accounted for in the same way as keratoconus, which is caused by a weakening of the centre of the cornea.

Now tension on the capsule will cause it to flatten the surface of the lens. Owing to the extreme thinness of the posterior capsule it will tend to stretch in that part rather than compress the lens substance. This point is borne out by the experimental model already mentioned. Thus it appears that the posterior lens capsule is distended to its utmost when the accommodation is relaxed and consequently does not increase much in curvature when the tension of the zonule is relaxed in accommodation. The advance of the apex is produced by the general swelling of the lens.

If the anterior capsule does not vary much in thickness, tension upon it will cause the anterior surface of the lens to be approximately spherical. This was seen in Case H. If, however, the central part of the anterior capsule be thin, the resultant surface will show a greater curvature in the centre than at the periphery; it will be hyperbolic in curve. This was seen in Case M.

The result of relaxation of tension by an act of accommodation is that the capsule becomes distended by the pressure of lens substance and the distension will be greatest where the capsule is weakest.

We have abstracted this paper at such length because it seems to us to be one of great importance, and one, the argument of which cannot be stated without following the author through his various steps. It seems to us that he has brought forward still more evidence in favour of the Helmholtz explanation of the act of accommodation and has taken away the necessity of any further hypothesis to explain the hyperbolic curve which caused Tscherning to formulate a new hypothesis. The experiments of Hess on the movements of the lens during accommodation and eserin miosis showed quite conclusively that the zonule was relaxed during accommodation, and although this relaxation did not explain the hyperbolic form the lens assumed during accommodation, the variations in thickness of the lens capsule emphasized by Fincham have supplied the clue to this extremely puzzling phenomenon.

The author is to be congratulated upon a very valuable and beautiful piece of investigation.

CHARLES GOULDEN.

II.—ANATOMY AND PHYSIOLOGY

(1) **Haden, C. Henry, M.D. (Houston, Texas).—The development of the connective tissue framework of the human optic nerve with especial reference to the lamina cribrosa.** *Amer. Jl. of Ophthal.*, January, 1925.

(1) **Haden's** paper is based on the histological investigation of eyes obtained from nine different foetuses varying from the ages of two and a half to nine months of intra-uterine life. The optic nerve and region of the lamina cribrosa were stained to differentiate between glial and fibrous connective tissue. At the outset, Haden notes a statement in a recent text-book of embryology to the effect that the formation of the lamina cribrosa is due to the nerve fibres growing through the preformed mesodermal layers of the choroid and sclera. His investigations go to prove the falsity of the statement and his findings are as follow: The primary framework of the optic nerve is ectodermal, being composed of glial cells and thin processes. The latter form an arrangement similar to a bundle of tubes within which lie the fibres of the optic nerve. Prior to the middle of the third month, there is no mesoderm within the optic nerve other than that incarcerated with the hyaloid artery. After this date fine endothelial capillaries grow inwards from the *anlage* of the pial sheath, accompanied by fibroblasts, and follow the direction of the glial partitions. These fibroblasts proliferate, and by the end of the seventh month nearly all the septa between the funiculi of the nerve are composed of fibrous tissue.

The processes of glial cells in the distal end of the nerve are coarser and are not invaded by fibrous tissue until a much later period. Where fibrous tissue does ultimately appear, it is a direct ingrowth of the scleral fibres and occupies only the posterior layers of the lamina, the anterior portion remaining glial throughout life. The paper is illustrated with twelve coloured drawings of microscopic slides.

F. A. WILLIAMSON-NOBLE.

(2) **Beauvieux and Ristitch.—The central vessels of the optic nerve. An anatomical study. (Les Vaisseaux centraux du Nerf optique. Étude anatomique.)** From the Ophthalmic Clinic of the Faculty of Bordeaux. *Arch. d'Ophtal.*, June, 1924.

(2) **Beauvieux** and **Ristitch** conducted an elaborate investigation into the arterial and venous circulation of the optic nerve by means of coloured injections. Their findings are described in detail in this paper, and illustrated by six excellent micro-photo-

graphs. The paper is interesting but too long to abstract satisfactorily. The following are the writers' conclusions:

"(1) The central artery of the retina is a terminal blood-vessel, in the sense that cerebral arteries are terminal. This is not surprising, since the retina is a cerebral extension and the optic nerve a commissure between the retina and the brain. The central artery is completely independent of neighbouring arterial areas, in the retrobulbar part of the nerve, which it supplies and especially at the level of the scleral ring, the cribriform lamina and the papilla. We know that in the retina each branch preserves its individuality.

"It follows, that it is impossible to explain the re-establishment of blood current which sometimes occurs in cases of arterial embolism or thrombosis by the development of a collateral circulation by way of anastomosing arterioles of the circle of Zinn. This conception has been supported by Sichel, Wecker, Nuel, Knapp, Nettleship, Dufour and Gonin. Although Leber described anastomoses at the level of the cribriform lamina he thought that these communications were too imperfect to allow the central artery to be considered anything but a terminal artery. We are more emphatic, for in no one of our experiments has there been any evidence of such anastomoses. It is, therefore, necessary to imagine that the blood supply flows along some pre-existing channel when the central artery has become blocked. This preformed channel can only be present in exceptional instances, as in a case reported by Gonin.

"(2) The cribriform lamina is dependent on the circle of Zinn and the short posterior ciliary arteries for its arterial supply. This statement merits attention. In a future article we shall show that this blood supply offers an explanation of the genesis of Schnabel's lacunae in glaucoma.

"(3) The central retinal vein has communication with the venous plexuses of the choroid and sclera, at the level of the scleral canal, similar to the communications which exist between neighbouring venous areas in the cerebrum. The venous anastomoses are specially demonstrable at the level of the lamina cribrosa, but their calibre is small except in one or two venules. Are they sufficient to take a share in the retinal venous blood flow in the presence of active or passive congestion at the posterior pole of the eye?

"In seeking a reply to this question we have examined numerous specimens of optic neuritis or blood stasis of diverse origin, but have never found pathological dilatation of these secondary channels; nor have we in any case found oedema or congestion of the choroid around the papilla, suggestive of abnormal circulatory conditions in the posterior part of the uveal tract. Conversely, in

studying sections of various types of choroid inflammation we have not noted papillary hyperaemia, which Vennemann states is inevitably induced by way of these venous anastomoses.

"We are of opinion, nevertheless, although it is not possible to adduce proof, that their existence may be valuable in the event of an obstruction to the blood current in the central vein. Thrombosis of the central vein is not rare and a noticeable and not infrequent sequence is secondary glaucoma. To what is the hypertension to be ascribed? Is it possible that these anastomosing venules, divert the retinal blood current towards the choroid or scleral plexus and in this way allow the ocular blood pressure to regain its equilibrium? Or, on the other hand, does hypertonus develop if the canals are quite incapable of performing their physiological task? If it is really so the exact site of the obstructing clot is of paramount importance. The venous anastomoses cannot exert their function unless the obstruction is situated behind the lamina cribrosa, *i.e.*, in the trunk of the optic nerve." Further observations are necessary to confirm or contradict this hypothesis.

J. B. LAWFORD.

(3) **Ferree, Prof. C. E. and Rand, Gertrude (Bryn Mawr College).** **Effect of brightness of pre-exposure and surrounding field on breadth and shape of the colour fields for stimuli of different sizes.** *Amer. Jl. of Ophthal.*, November, 1924.

(3) **Ferree** and **Rand** have published many papers on the subject of colour fields, the present paper being one of the series. When a small coloured stimulus, surrounded by a field, for example, of black or white, is viewed, a sensation is given which consists of the colour mixed with black or white, due to a contrast sensation induced by the surrounding field. In consequence, there is (*a*) a quantitative inhibition of chromatic excitation. In the central retina, with good illumination, white surroundings inhibit the colour most and black least. There is also (*b*) a qualitative inhibition which varies with the state of adaptation and the part of the retina stimulated. For example, in the light-adapted eye, yellow mixed with black becomes greenish and blue mixed with white or light grey becomes a reddish blue. In peripheral vision, the changes are greater in amount, and not always in the same direction. With regard to pre-exposure, if this differs in brightness from the colour to be used, it gives an after image which mixes with the colour, reducing its saturation and altering its tone. If the pre-exposure is brighter, the effect is to add black to the colours, if darker, to add white. It was found that the eye was rendered most sensitive if the pre-exposure was grey of the same brightness as the colour. It has to be borne in mind that the after

image reaction of the peripheral retina is extremely quick, and that there is no latent period. Numerous fields were taken with test objects of various sizes, the surrounding fields being black, white or grey of the same brightness as the colour used. The largest fields were obtained when the pre-exposure and surrounding field were grey. This applied to all the colours except blue, in which the small 0.17 degree stimulus was used, when black gave a better result. The reason given for this is that the blue was a close match for the grey.

F. A. WILLIAMSON-NOBLE

III.—TUMOURS

(1) **Barnert, Cyril (New York).—Report of a case of chloroma of the orbit.** *Arch. of Ophthal.*, September, 1924.

(1) **Barnert,** before describing his case gives a useful summary of the literature, culled from some hundred and fifty references. With regard to incidence the average age is 18 years. The disease is essentially fatal, the average duration being three to four months. Onset is usually marked by the occurrence of exophthalmos, which rapidly increases and is accompanied by loss of visual acuity. New tumours form in the skull bones and leukaemia develops. There are purpuric rashes and a rapidly progressive secondary anaemia. Tumours may be found in the skin, bones or any of the viscera. The blood picture is that of an acute myeloblastic leukaemia with rapid diminution of the platelets and haemoglobin. There is a close resemblance between myeloblasts and lymphocytes so that the condition may be mistaken for lymphatic leukaemia. Chloroma is essentially a malignant disease of the bone marrow, the type cell being the myeloblast. The tumours extend through the cortex of the bone and spread over the periosteum. The cells are not only carried rapidly to other parts of the body but actually undergo metastasis in the blood stream itself. The light olive-green colour of chloroma is not necessarily present in all the tumours. Its exact composition is not yet known, but it is due to the presence of myelocytes. The colour fades after a few minutes exposure to light but can be restored by hydrogen peroxide or ammonia.

Interesting points in the case reported are: The onset with exophthalmos was noted the day after the patient had been hit in the face by another child. An X-ray photograph taken at one period showed a fracture of the orbit, so that the condition was taken at first for haematoma. At the first exploratory operation only

fibrinous material was found in the portion removed for examination. The blood picture was that of an acute myeloblastic leukaemia, the polymorphs being reduced to 30 per cent., the lymphocytes not affected, and the myeloblasts and myelocytes being increased up to 25 per cent. X-ray treatment had little effect, and the child died one month after admission to hospital at the age of 2½ years. A chloroma was present in the left orbit, the side first affected, and no fracture was found in the bone. The lungs, suprarenals and kidneys showed some greenish discolouration, bone marrow from the femur was chocolate coloured and semi-solid. No definite tumours were found in the skull bones but there were some greenish areas involving the dura and lining periosteum.

F. A. WILLIAMSON-NOBLE.

(2) **Cange, A., and Argaud, R. (Algiers). — Orbito-temporal dermoid cyst. (Le kyste dermoïde orbito-temporal.)** *Arch. d'Ophtal.*, October, 1923.

(2) **Cange** and **Argaud** describe a case of bilocular dermoid cyst in a man of 45 years of age. A tumour had been first noticed at the age of fifteen in the most anterior part of the left temporal fossa near the end of the eyebrow. Three months before the patient came under the care of the authors the tumour had grown rapidly and marked exophthalmos had also developed (a photograph illustrates the appearance). With the exception of a slight contraction of the visual field there were no objective symptoms and the vision of the eye was normal. During the operation for the removal of the cyst, which necessitated a fairly considerable bony resection, a communication was found at the point of junction of the frontal, malar, and great wing of the sphenoid leading to a second cyst in the back of the orbit. Both were successfully removed with an excellent cosmetic result and the recovery of the slight loss of the field of vision. Microscopical examination confirmed the diagnosis of a dermoid cyst. The paper concludes with a discussion of the embryological origin of such cysts.

E.E.H.

(3) **Weekers, L. (Liège).—Primary melano-sarcoma of the ciliary body. (Mélanosarcome primitif du corps ciliaire.)** *Arch. d'Ophtal.*, October, 1924.

(3) **Weekers** publishes a description of two examples of this somewhat rare form of malignant tumour of the eye, with illustrations of microscopic sections of the tumours. They are good specimens of two types of sarcoma arising in the ciliary body.

Case 1.—In a man, aged 65 years; here the tumour developed in the anterior part of the ciliary body and the root of the iris, and invaded the anterior chamber. Pigmentation, especially in the ciliary portion, was moderate in degree.

Case 2.—In a man, aged 24 years; here the neoplasm developed in the pigmented cells of the ciliary processes and invaded the vitreous, forming a pedunculated tumour; in its histological characters it was a true melanoma consisting almost entirely of pigmented cells.

J. B. LAWFORD.

(4) **Donnell, N. R. (St. Louis).—Perithelioma of upper eyelid.** *Arch. of Ophthal.*, September, 1924.

(4) This report by **Donnell** concerns a woman, aged 74 years, who in April, 1923, complained of a tumour of the left eye. It had first appeared six years previously as a small lump on the left upper lid over the site of a chalazion which had been incised and curetted. The growth was the size of a walnut and appeared to arise well back under the upper lid. The orbit was exenterated and during the operation it was seen that the growth arose from the tarsus, most of which was absorbed. The chief feature in the microscopical examination of the specimen, was the presence of solid masses of cells of varying size and shape with red blood cells compactly arranged between them. A thin-walled blood-vessel was seen, more or less centrally placed, in many of the cell masses. A similarity is noted between the appearances here and those in glioma retinae, with the difference that in the present case the cells farthest from the nutrient vessel have not only regressed but have also undergone absorption. Giant cells were fairly numerous and in some parts of the growth the alveolar arrangement had broken down, the appearance becoming sarcomatous. The exact origin of these tumours is still *sub judice*. The existence of the perithelial cells described by Ebutt in 1870 has not yet been confirmed, as it is difficult to differentiate them from the endothelial cells of the perivascular lymphatics. Clinically, these growths are commonest in the loose subcutaneous tissue of the anal region, orbit, axilla, popliteal space and the regions of the embryonic fissures, but not in the more exposed regions. This suggests "a relation to embryonal disturbance of superfluous tissue." Only three cases of perithelioma have been described in the eyelid.

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3. **Charsley, R. S.**—*Amer. Jl. of Ophthal.*, Vol. III, p. 687, 1920.

F. A. WILLIAMSON-NOBLE.

(5) **Ruiz, R. del C. (Madrid).—Lymphosarcoma of the upper lid. (Linfosarcoma del Párpado Superior.)** *An. de Oftal.*, January, 1925.

(5) The great rarity with which these neoplasms occur in the lid makes the case described by **Ruiz** of considerable clinical interest; he has been able to gather only 31 cases of this class of lid tumour in the whole of the world's literature.

There is a history of twelve months, during which time the patient, a young adult male, noticed a slowly-growing, symptomless tumour develop in the substance of the right upper lid. At the end of this period, it had attained a considerable size, and had induced a definite ptosis and narrowing of the palpebral fissure. The skin was quite free and appeared normal, and on palpation was found to be easily movable over a smooth, regular, oval mass of ebony consistency, which lay horizontally across the lid in apparent close relation to the tarsal plate. Eversion of the lid, a manoeuvre which elicited considerable pain, revealed the tarsal conjunctiva in its lower part covered by follicles which increased in size towards the ciliary margin. Several enlarged vessels traversed the palpebral conjunctiva, running from the region of the fornix, and appearing to lose themselves in the substance of the tumour.

In the differential diagnosis, the general appearance and the close relation to the tarsal plate suggested a specific tarsitis, a possibility rendered more probable in this case by the fact of a positive Wassermann reaction, and a definitely specific family history. To exclude this a histological examination of an excised portion was made which revealed a typical lymphosarcomatous structure, with the richly-chromatined atypical cells in active mitotic division.

In discussing the possibilities of treatment Ruiz remarks on its difficulty. Two methods of attack are suggested, excision, and destruction by diathermy followed by a course of radium, or X-ray therapy. Of these the latter was chosen as holding out a fair chance of cure with the minimum of trauma. Were the former considered, the method may be either conservative or radical. The most feasible of the less extensive operative procedures is suggested as a total excision of the upper lid, with a facio-plastic reconstruction after the manner of Fricke, replacing the palpebral conjunctiva by oral mucosa. This is rejected in that it is not ample enough to negative recurrence with any certainty; in that the new lid, being immobile and drooping, would not only fail to protect the globe, but, being of foreign epithelium, and remaining dry in the absence of lacrymal secretion, would so damage the cornea and ocular conjunctiva that the usefulness of

the eye would be sacrificed, and any attempt at its preservation thus nullified; and finally, in that the immobility of the drooping lid would itself forbid vision, and destroy any attempt at an aesthetic result. The more radical alternative—extirpation of the lid and the neighbouring structures, removal of the eye, and sealing over the exenterated orbital cavity by autoplastic procedures—is to be preferred.

W. S. DUKE-ELDER.

(6) **Cohen, Martin (New York).—Report of a case of melano-sarcoma of the choroid followed by phthisis bulbi and irido-cyclitis in both eyes.** *Arch. of Ophthal.*, January, 1925.

(6) **Cohen's** case is of interest because it shows that sympathetic ophthalmitis may occur as the result of a melano-sarcoma of the choroid in the exciting eye, apart from any trauma. The patient was a male, aged 35 years, who suffered from multiple arthritis, and had a history of infection with syphilis and gonorrhoea. Wassermann and gonococcal fixation tests were negative and no gonococci could be found after prostatic massage. He was found to have a melano-sarcoma of the left eye, but refused enucleation. Ten months later the eye became inflamed and within four months began to shrink. Three months after this, the right eye which was previously unaffected showed signs of irido-cyclitis, with deterioration of vision which was eventually reduced to hand movements. The left eye was excised and found to contain a melano-sarcoma of the choroid which had become necrotic in some areas and had produced a plastic irido-cyclitis with phthisis bulbi. No micro-organisms could be found and there was no sign of perforation. Though the irido-cyclitis was of the plastic type the typical histological appearances of sympathetic ophthalmitis, giant cells and numerous lymphocytes, were absent. It was considered unlikely that systemic or focal infections caused the plastic irido-cyclitis in the other eye because of: (1) The long period during which laboratory findings for infections remained negative; (2) the long delay of the occurrence of any acute eye manifestations after a history of initial infection; (3) the length of the interval—namely three months—between the involvement of the two eyes. On the other hand, the multiple arthritis was of unknown origin and it was possible that the same unknown infection could have produced irido-cyclitis in the less resistant sarcomatous eye and after an interval in the previously sound and more resistant right eye. The author believes, however, that necrosis of the sarcoma was the cause of the irido-cyclitis in the left eye and the exciting cause of an inflammation clinically like sympathetic ophthalmitis in the other eye. His reasons are: (1) The presence of a plastic irido-cyclitis in both eyes; (2) the sequence in the clinical pathology of

both eyes; (3) the absence of any proof of definite systemic infection, which if present would, as a rule, have produced a plastic irido-cyclitis in both eyes simultaneously.

F. A. WILLIAMSON-NOBLE.

IV.—MISCELLANEOUS

(1) **Wojno (Sofia).—A rare complication after a subconjunctival injection of NaCl. (Seltene Komplikation nach subconjunctivaler NaCl-injektion.)** (Polish.) Abs. *Zentralb. f. d. gesam. Ophthal.*, May 6, 1924.

(1) **Wojno** reports two cases, where, after subconjunctival injection of 2 per cent. NaCl, pain, and damage to the corneal epithelium were observed. This quickly passed off. He is of opinion that it is due to a hypersensitiveness of the nerve endings in the cornea. That it is not caused by the cocain included in the injection is proved by the fact of its occurring when the NaCl was injected alone.

S. SPENCE MEIGHAN.

(2) **Blatt, Nicolas (Roumania).—A case of blue sclera, fragilitas ossium and primary epibulbar carcinoma. (Ein Fall von blauer Sclera, Knochenbrüchigkeit und primärem epibulbärem Carcinom von basocellulärem Charakter.)** *Arch. f. Ophthal.*, Vol. III, 1923.

(2) **Blatt's** case is remarkable from the fact that the patient attained an advanced age, and therefore belongs to the class of *fragilitas ossium idiopathica tarda*. The patient was a woman, aged 52 years, who from childhood had had "blue eyes" and difficulty of hearing. In the course of her career she sustained a fracture of the ninth rib with dislocation of the shoulder, further a fracture of the left arm and one of the right thigh bone. Slight trauma was sufficient to produce repeated dislocation of the shoulder. At the age of 50 years a slowly-growing tumour made its appearance in the left eye. Examination showed that this tumour extended from the caruncle to beyond the edge of the cornea, presented the form of a shell, had a broad base and was firmly fixed to the parts beneath. The surface was uneven, but not ulcerated, the colour greyish-white. It had apparently developed on an old pterygium. Removal of the tumour was easy; nowhere had it penetrated into the deeper parts. Histological examination showed irregular epithelial masses, separated by stroma at the cut surfaces. The

cells were partly cylindrical, partly cubical, but flattened types were also observed. A few giant cells, here and there kariokynetic figures. No regressive changes. Obviously, a case of epibulbar carcinoma of the baso-cellular type. In the patient's family fragility of the bones, blue sclerotics and deafness were hereditary, but there was no disposition to the development of cancer. The author believes that the sclera, which in spite of its thinness possessed unusual firmness, must have prevented the tumour from proliferating into the interior of the eye, while the abundant blood supplied by the pterygium forming the base of the tumour probably accounted for the absence of ulceration. The pterygium itself acted no doubt as an irritative cause in the development of the carcinoma.

V. ST. JOHN.

(3) **Blatt, Nicolas (Roumania).—Relation between intra-uterine resorption of opaque lens and microphthalmos. (Beziehung zwischen den intra-uterinalen Resorption der getrübten Linse und dem Mikrophthalmus.)** *Klin. Monatsbl. f. Augenheilk.*, Vol. LXVIII, 1922.

(3) **Blatt** describes a case of unilateral congenital cataract with almost complete resorption of the lens, and incomplete development of the eye and corresponding orbit. The cataract is explainable as a transformation occurring in the later months of uterine development, the consequence probably of a trauma which produced rupture of the pupillary membrane (of which remains were noted), and of the lens capsule. In the absence of the impulse provided by the growing lens the eye and orbit remained incompletely developed. Weakness of sight is also to be explained by absence of developmental impulse with consequent insufficient differentiation of the retina. *Amblyopia ex anopsia*, with well developed retina, does not exist, according to the author. Conculsion: In order to avoid maldevelopment of the eye, congenital cataract need not be operated on in the first two years, since the danger of *amblyopia ex anopsia* does not exist.

V. ST. JOHN.

(4) **Koby, F. E. (Paris).—Contribution to the study of chromheteropia. Iridic heterochromia as a manifestation of mixed heredity. (Contribution a l'étude de la chromhétéropie. Hétérochromie irienne comme manifestation d'hérédité en mosaïque.)** *Rev. Gén. d'Ophtal.*, February, 1921.

(4) Chromheteropia is the name which **Koby** prefers for the condition usually known in this country as heterochromia. The article is of some length, so that it may be sufficient to condense

the conclusions reached. Heterochromia iridis is most often the indication of degeneration of the eye, with or without affection of the sympathetic. The pathogenesis is obscure. It may be congenital and associated with other anomalies. Sometimes it is the result of unilateral hyperpigmentation, which usually extends to the sclerotic, etc. The cause may be atavism, since the lightly pigmented human races are descended from much pigmented ancestors. An interesting form of heterochromia is produced by what the author terms *hérédité en mosaïque*, translated by the reviewer as "mixed heredity," though that may not be the best translation. This may also be observed in the domestic animals. It indicates repeated crossings of pigmented with depigmented races. It cannot be admitted in such cases that the light eye is inferior to the other. This form is very rare.

ERNEST THOMSON.

(5) **Lo Cascio, G. (Rome).—On the causes of the red colour of the fundus oculi. (Sulle cause del colorito rosso del fondo oculare.)** *Ann. di Ottal. e Clin. Ocul.*, Vol. LII, No. 5, pp. 333-343, 1924.

(5) **Lo Cascio** mentions three theories as to the causation of the red colour of the fundus: (1) That it is due to the blood in the choroidal vessels; (2) that it is due to the visual purple; and (3) that it is mainly due to the pigment epithelium of the retina. He quotes many authors, German and French, on these various views, the majority of whom give greatest importance to the choroidal blood. The author states that those who support the pigment epithelium theory base their views on the researches of Marx (*Die Ursache der rotem Farbe, etc., Arch. f. Ophthal.*, Vol. LXXI, p. 141), who pointed out that if the red colour is due to blood in the choroidal and retinal vessels, the light reflected from the fundus should, on spectroscopic examination, show the absorption bands of haemoglobin.

The experiments of Marx were of two kinds. He attached a spectroscope to an ophthalmoscope, and examined the eyes of four young men, and an albino rabbit. In the men he found no absorption bands, but diminished luminosity of the yellow and marked shortening of the violet end of the spectrum. In the albino rabbit he found the absorption bands of oxyhaemoglobin, and he concluded that in man there is something in front of the choroid which prevents it having any influence on the colour of the fundus, and that this must be the pigment epithelium of the retina, which is lacking in the albino rabbit.

Marx's other experiment was to wash out the vessels of the eyes of two still-born children with salt solution, and examine the fundi

ophthalmoscopically. He found the fundi as red as before the washing. Lo Cascio has repeated Marx's experiments. In albino rabbits he found in the region between the D and E lines the two absorption bands characteristic of oxyhaemoglobin. In pigmented animals, and using intense illumination, he usually found no band of absolute absorption but a zone of diminished luminosity between 580$\mu\mu$ and 566$\mu\mu$ which corresponds with the left (longer wave-length) band of haemoglobin. He was not able to find this in black rabbits. Examinations in man gave similar results.

The other experiments consisted in washing out the vessels of the head in recently killed animals. Ophthalmoscopic examination showed complete, or very nearly complete, loss of the red colour of the fundus. He suggests that Marx in his experiments allowed clotting to occur before he attempted to wash out the vessels.

Lo Cascio concludes that the red colour of the fundus is mainly due to absorption of light by the blood in the choroidal and retinal vessels, but that in heavily pigmented eyes the light from the choroid is mixed with light reflected from the retinal epithelium.

ARTHUR GRIFFITH.

BOOK NOTICE

Hutchison and Sherren: An Index of Treatment, by various writers. Ninth edition. Revised and enlarged. Roy. 8vo, pp. 18 and 1035. Bristol: John Wright & Sons, Ltd. 1925. Price, 42s. net.

A book that has reached its ninth edition needs no words of ours to recommend it. First published in 1907, it has gone on from strength to strength; the last edition came out in 1921. In the present issue all articles have been carefully revised and a few new subjects have been included. The chief alterations occur in the sections on asthma, diabetes, syphilis and tropical diseases, while recent advances in therapeutics find due mention.

The fact that the sections on ophthalmic disorders are by Sir William Lister is a guarantee of their completeness and accuracy. The supplementary index runs to nearly thirty pages, the matter being arranged in three columns to the page. The publishers are to be congratulated on the get-up of the work.

NOTE

Death

THE death is annuonced on June 28, 1925, of Adolph Vossius. He was born in 1855, and worked principally at Königsberg, and under A. von Hippel at Giessen.

FUTURE ARRANGEMENTS

1925

October 6.—Midland Ophthalmological Society (Annual) at Birmingham.

October 9.—Royal Society of Medicine, Section of Ophthalmology.

October 16.—North of England Ophthalmological Society at Manchester.

November 6.—North of England Ophthalmological Society at Leeds.

November 13.—Royal Society of Medicine, Section of Ophthalmology.

December 4.—North of England Ophthalmological Society at Bradford.

December 11.—Royal Society of Medicine, Section of Ophthalmology (Clinical).

1926

January 8.—Royal Society of Medicine, Section of Ophthalmology.

February 5.—North of England Ophthalmological Society at Liverpool.

February 12.—Royal Society of Medicine, Section of Ophthalmology.

March 5.—North of England Ophthalmological Society at Sheffield.

March 12.—Royal Society of Medicine, Section of Ophthalmology (Clinical).

May 14.—Royal Society of Medicine, Section of Ophthalmology.

June 11.—Royal Society of Medicine, Section of Ophthalmology (Annual).